



United States Department of Agriculture
Forest Service

Shasta Agness Landscape Restoration Project

Geology & Soils Report

Gold Beach Ranger District, Rogue River-Siskiyou National Forest, Curry County, Oregon

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Oak-savannah restoration treatment, Stand 2. South of stand unit 2 a side slope natural failure, common in the Tertiary marine and nonmarine sedimentary rocks, above Shasta Costa Creek is viewed from the junction of Bear Camp Road and Road 2300990. Photo Credit: Lizeth Ochoa

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I. Introduction

The Shasta Agness Landscape Restoration Project (Shasta Agness) is located on the Gold Beach Ranger District and Wild Rivers Ranger District of the Rogue River-Siskiyou National Forest, Curry County, Oregon. The planning area is approximately 92,000 acres and is located approximately 30 miles northeast of Gold Beach, Oregon. The project area includes National Forest System (NFS) lands surrounding the community of Agness.

The proposed action for this project (DEIS Alternative 1) would enact multiple actions across the Shasta Agness landscape. These actions would: A) restore unique ecosystems through vegetation treatment and management, and promote late seral habitat development; B) restore and protect aquatic and riparian habitat conditions; and C) provide recreational user opportunity.

The following tables summarize the estimated footprint of each proposed action and alternative:

Table 1. Estimated silvicultural treatment acres within Shasta Agness Planning Area.

Unique Landscape Restoration ²	Alternative 1	Alternative 2	Alternative 3
Oak Habitat Restoration (acres)	2199	2199	1147
Serpentine Pine Restoration (acres)	484	0	484
Sugarpine Habitat Restoration (acres)	549	0	531
Candidate Plantation Thinning Treatments (acres)	1635	1635	1635
Port Orford Cedar Sanitation (acres)	241	0	241
Burn Between ³ (acres)	1859	851	0
Adaptive Fire Re-entry (acres)	6726	4685	3797
Total Vegetation Treatment (acres)	6967	4685	4038
Difference in Vegetation Treatments Relative to Alternative 1 (acres)	0	-2282	-2929

Table 2. Estimated road mileage of proposed treatments within Shasta Agness Planning Area.

Sustainable Roads	Alternative 1	Alternative 2	Alternative 3
Road Openings (ML1 to ML2) (miles)	1	1	0
Road Storage (ML2 to ML1) (miles)	10	4	9

² Riparian Thinning and native species planting is a subset of the total acreage calculated in Unique and Candidate Plantation treatment units.

³ Additional burn outside and between identified candidate stand treatment units.

Road Decommissioning (miles)	6	6	10
Haul Routes (miles)	193	151	192
Non-System Road Template Re-used (miles)	12	10	12
New Temporary Roads (miles)	5	4	0

Table 3. Estimated footprint for aquatic and riparian habitat treatments within Shasta Agness Planning Area.

Aquatic and Riparian Habitat Treatments	Alternative 1	Alternative 2	Alternative 3
Instream Large Wood Placement (miles)	29	29	29
Removal of Aquatic Organism Passage Barriers (Quantity)	8	8	0
Beaver Reintroduction and/or Beaver Dam Analogues (Sites)	5	0	0

Table 4. Estimated acreage of sustainable recreation improvements within Shasta Agness Planning Area.

Sustainable Recreation Improvements ⁴	Alternative 1 (acres)	Alternative 2 (acres)	Alternative 3 (acres)
Billings Cr Dispersed Campground Decommissioned	0.2	0	0.2
Foster Bar Facility Maintained	2.8	2.8	2.8
Foster Bar Launch Improved	0.4	0.4	0
Illahee CG Decommission	9.9	0	9.9
Illahee CG Reopened	0	15.7	0
Illinois TH Horse Camp (new)	0	1.1	0
Oak Flat CG Host	0.3	0.3	0.3
Oak Flat CG Boat Ramp/Water	0	21.8	0

⁴ All recreation facilities have the potential to implement off highway vehicle mitigation, signage, invasive removal, trail and/or trailhead maintenance, and resource damage repairs.

**Depending on the chosen alternative decommissioning or development of campground would include obliterating road system or improving access to recreation site.

Shasta Costa Maintenance	1.2	1.2	1.2
Shasta Costa Campground (new)	0	8.1	0
Upper Rogue TH Improvements	0.1	0.1	0
Totals Acres	14.9	51.5	14.4

Table 5. Trails proposed for each alternative within the Shasta Agness Planning Area.

Trail Name	Trail Type	Alt. 1 (mi.)	Alt. 2 (mi.)	Alt. 3 (mi.)
Big Bend Battlefield trail	New trail	0	1.4	0
Foster Cr to Brewery Hole trail	New trail	0	0.8	0
Foster/Brewery tie-in w/Up. Rogue trail	New trail	0	0.1	0
FSR 2308330 to OHV trail	Motorized trail	0.7	0.7	0
FSR 3577350 to OHV trail	Motorized trail	3.6	3.6	0
Nancy Cr trail 1181 decommissioned	Decomm. trail	1.9	0	1.9
Shasta Costa Creek trail	New trail	0	4.3	0
Shasta Costa Overlook A	New trail	0	2.8	0
Shasta Costa Overlook B	New trail	0	1.9	0
Total miles		6.2	15.6	1.9

This report will describe background geology and analyze effects to existing soil resources within the Shasta Agness Planning Area, more specifically, soil productivity and slope stability. Strongly associated resources are described and analyzed in the following specialist's reports:

- a) Hydrology Report
- b) Silviculture Report

II. Information Sources and Analysis Methods

Development of watershed analyses is directed in the Northwest Forest Plan. Information and analysis has been gathered into a series of documents that describe the subject area, human and natural disturbances, and current condition. In addition, the Travel Management Planning Record of Decision and Travel Analysis Report were referenced to gather information on the road system within the Shasta Agness planning area. Recommendations for restoration of degraded areas have been excerpted where appropriate to this proposed action.

Map information for this report was generated through the Rogue River- Siskiyou National Forest's (RRSNF) Geographic Information System (GIS) database on ArcMap version 10.3.1

software (ESRI). Geophysical shapefiles, using soil survey data available from the Natural Resource Conservation Service, were completed across Oregon and Washington by the Department of Crop and Soil Science (CSS), Oregon State University, Corvallis, OR and the USDA Forest Service- Region 6 Office, Portland, Oregon. In addition, modeling efforts utilizing tools in ArcMap to estimate the relative risk of slopes in the planning area to instability and erosion were completed. The following data layers were queried for the project from these sources:

RRSNF GIS Database
Streams/wetlands
Hydrologic Units
Recreation
Roads
Managed Stands
Land status/management allocation
Late Successional Reserve boundary
NRCS Soils Mapping
DOGAMI- Geologic Compilation Version 5 ⁵
Aerial Photography (NAIP Imagery)
Serpentine Influenced Soils
Landslides
Landflows

USDA Forest Service/Department of CSS GIS Data
Available Water Storage to 150 cm or Restricted Layer
Droughty Soils
Geology ⁶
Landform Associations

Soil water holding capacity mapping

Soil water holding capacity mapping was completed across Oregon and Washington by the Department of Crop and Soil Science, Oregon State University, Corvallis, OR and the USDA Forest Service - Region 6 Office, Portland, Oregon, utilizing physical soil attributes from soil surveys that are available. The following paragraph from the metadata in GIS explains the methods used to develop this mapping:

“Available water holding capacity to a depth of 150cm was calculated from the best available soil information across the Pacific Northwest Region; units are mm. The information came from NRCS Soil Surveys published in the Soil Survey Geographic Database (SSURGO) at a scale of 1:24,000 and from USFS Soil Resource Inventories (SRIs) at a scale of 1:63,360 where SSURGO

⁵ (DOGAMI) Oregon Department of Geologic and Mineral Industries. 2009. Oregon Geologic Data Compilation (OGDC) – Release 5.

⁶ The geologic map unit (GeologyMapUnitsorder1) feature class polygons are attributed with stratigraphy, lithology, geomorphology, and descriptive text. The maps are typically compiled from State or Federal geologic mapping, but may come from university mapping efforts or from FS project-level mapping.

is not available. Calculations of Available Water Holding Capacity (AWHC) – that soil water available for plant uptake, were determined by soil horizon based on the following formula: $AWHC = (W1/3 - W15) \times (Db \ 1/3) \times Cm / 100$ AWHC = volume of water retained in 1 cm³ of whole soil between 1/3-bar and 15-bar tension; reported as cm cm⁻¹ [numerically equivalent to inches of water per inch of soil (in in⁻¹)] W1/3 = weight percentage of water retained at 1/3-bar tension W15 = weight percentage of water retained at 15-bar tension Db1/3 = bulk density of <2-mm fabric at 1/3-bar tension Cm = rock fragment conversion factor derived from: volume moist <2-mm fabric (cm³) / volume moist whole soil (cm³). The SSURGO survey has lab data of available water holding capacity by horizon. For the SRI, we used a soil texture relationship for W1/3 – W15 based on NRCS lab data for similar textures. We use a bulk density of 1.00 g/cc for surface and 1.25 g/cc for subsurface (0.75/1.00 g/cm for soils influenced by ash). All calculations on the output map are for the dominant soil in the soil map unit only. A single soil map unit may contain a complexes of 2-3 distinct soil types, some similar and some contrasting in their attributes. Similar output maps can be made for the minor components in the soil map unit.”

The mapping used for the Shasta Agness analysis utilizes the calculations based on the dominant soil in the soil map unit. Using the dominant soil type for the landscape-scale size of the analysis area captures the soil characteristics that are most commonly encountered across the landscape and are considered adequate for this analysis. Project design and layout at the site scale would further take into account the variability of soils at the site level, manifested in the vegetation communities they are supporting.

Slope Stability and Erosion Risk Mapping

The following section explains tools utilized to develop the relative risk of slope stability and erosion, which was first used to aid in the evaluation of the *Coastal Healthy Forest Treatments (CHFT)* project area analyzed in December 2006. Subsequently, field verification of project activities within the area modeled have been confirmed to be accurate and adequate for NEPA analysis on the RRSNF. A narrative excerpt from the CHFT EA is below describing the development of the model:

“The following discusses the tools used in modeling the terrain characteristics used in this analysis. These attributes include slope gradient, slope aspect, slope curvature, and upslope contributing area.

The slope gradient tool in ArcMap utilizes the DEM to identify the steepest downhill slope for a location on a surface. Slope gradient was measured as percent slope. Percent slope of an area is a measure of the change in height (elevation over a measured distance). Slope is calculated for each cell in a raster map. It is the maximum rate of change in elevation over each cell and its eight neighbors. The lower the slope value, the flatter the terrain while the higher the slope value, the steeper the terrain.

The slope curvature tool was used as measure of the shape of the slope. The curvature of a surface is calculated on a cell-by-cell basis using a surface composed of a 3 cell by 3 cell window. The output of the curvature model can be used to describe the physical characteristics of a drainage basin in an effort to understand erosion and runoff processes.

A positive curvature indicates that the surface is upwardly convex at that cell. A negative curvature indicates that the surface is upwardly concave at that cell. A value of zero indicates

that the surface is flat. Curvature of the slope affects the acceleration and deceleration of flow and, therefore, influences erosion and deposition.

Upslope contributing area is also termed “flow accumulation”. The accumulated flow is a value based upon the number of cells flowing into each cell in the raster. The flow accumulation tool utilizes slope aspect to determine the direction of flow for each cell. The results of the flow accumulation tool were then used to create a stream network by applying a threshold value to select cells with a high accumulated flow. This method of deriving accumulated flow from a DEM is presented in detail in Jenson and Domingue 1988.

By adjusting the threshold value, the accumulated flow model can identify the areas where streams originate and thus identify headwall areas where instability might be a concern.”

A soils “risk” map (see Figure 9) was developed by combining the resultant maps from the tools described above. The combined factors were categorized as shown in Table 6 below. This map is essentially a combination erosion risk and slope stability risk map.

Table 6. Description of values corresponding to risk rating.

Terrain Feature	Value	Rating
Curvature	< (-3)	Very High
Slope	> 65% & > 2.5 acres	Very High
Flow Accumulation		
Slope	> 65%	High
Flow Accumulation	> 2.5 acres	High
Flow Accumulation	0.2 – 2.5 acres & 25 – 65%	Moderate
Slope		
Flow Accumulation	< 0.2 acres & < 30 - 65%	Moderate
Slope		
Flow Accumulation	0.2 – 2.5 acres & < 25%	Low
Slope		
Flow Accumulation	< 0.2 acres & < 30%	Low
Slope		

III. Management Direction

Land management direction is contained in the Siskiyou National Forest (SNF) Land and Resource Management Plan (LRMP) (USDA Forest Service 1989) as amended by the Northwest Forest Plan (USDA Forest Service and USDI Bureau of Land Management 1994). The Shasta Agness Planning Area contains four Management Allocations: Congressionally Reserved Areas, Late Successional Reserves (LSR), Riparian Reserves, and Matrix. The majority of the area is allocated to Late-Seral, as carried forward from the 1989 LRMP as General Forest Prescription (Management Area (MA) 14), as well as NWFP Riparian Reserve and LRMP Management Prescription MA-11. Additional Management Prescriptions include: Wilderness (MA-1), Wild River (MA-2), Botanical (MA-4), Unique Interest Area (MA-5), Backcountry Recreation (MA-6), Supplemental Resource (MA-7), Designated Wildlife Habitat (MA-8), Special Wildlife Site (MA-9), and Scenic/ Recreation River (MA-10). However no harvest treatments are proposed in MA-1, MA-2, MA-4, MA-5, MA-6, and MA-8 areas.

The authorities governing Forest Service soil management are outlined in Forest Service Manual (FSM) 2550 – Soil Management (WO Amendment 2500-2010-1, Effective November 23, 2010). Regional direction for maintaining and protecting the soil resource from detrimental disturbance to soil productivity is given in FSM 2500 – Watershed Protection and Management, Region 6 Supplement No. 2500-9801.

The Siskiyou National Forest (SNF) LRMP provides standards and guidelines (S&Gs) for soil and water resources on pages IV-44 through IV-48. In regard to soils and geology, they include S&Gs for detrimental soil conditions, soil erosion, mass movement, and large woody material.

Detrimental soil conditions include compaction, displacement, puddling, and severely burned soil conditions. Detrimental soil conditions are further defined in FSM 2500, Region 6 Supplement No. 2500-98-1. On the Siskiyou National Forest, the total area of detrimental soil conditions should not exceed 15 percent of the total acreage within the activity area, including roads and landings (S&G 7-2, page IV-44) (Siskiyou National Forest, 1989).

Surface organic matter (duff, litter) is vital for protecting surface soils from erosion. Mineral soil exposure (loss of duff and litter) should not exceed the following limits (ibid.):

- 40% mineral soil exposed on soils classed low-to-moderate erosion hazard;
- 30% mineral soil exposed on soils classed high erosion hazard;
- 15% mineral soil exposed on soils classed very high erosion hazard.

Standards and Guidelines for large woody material stress the importance of addressing site-specific needs. In general, five to twenty pieces of large woody material per acre should remain on each site; material should be from a range of decomposition classes; each piece should be at least 20 inches in diameter at the large end and contain at least 40 cubic feet volume (ibid.). To better guide site-specific needs, additional tools based on Plant Association Groups (PAGs) and down wood information collected with stand exam data, are used to refine the large woody material prescriptions. Because the Forest's PAG data is at a finer scale, the Forest is currently using plant series data from new PAG classifications, delineated by geographical regions (Cascades, Siskiyou, Coast), for determining snag and down wood objectives on the Rogue River-Siskiyou National Forest (refer to the Wildlife Report and Silvicultural Diagnosis for more detail).

In addition, the Northwest Forest Plan requires that all unstable areas and potentially unstable areas be managed as Riparian Reserve.

IV. Best Management Practices

Best management practices/mitigation measures design criteria were developed for the protection of soils, site productivity, and water quality. Best management practices are described in the National Core BMP Technical Guide (USFS 2012), and are required to ensure compliance with the regulatory framework for the soil resource and/or to reduce the risk of adverse impacts to the soil resource. While the terminology in the General Water Quality Best Management Practices, Pacific Northwest Region, November 1988 (USFS 1988) BMPs is dated and the 2012 BMPs supersedes the 1988 BMPs (for example Streamside Management Unit now falls under Riparian Reserve), they are still considered effective under today's management direction. A brief description is provided in Appendix B of the Shasta Agness Final Environmental Impact

Statement (DEIS) as to when, where and how the design feature should be applied and/or what conditions would trigger the need to apply the design feature.

V. Affected Environment

A. Geology

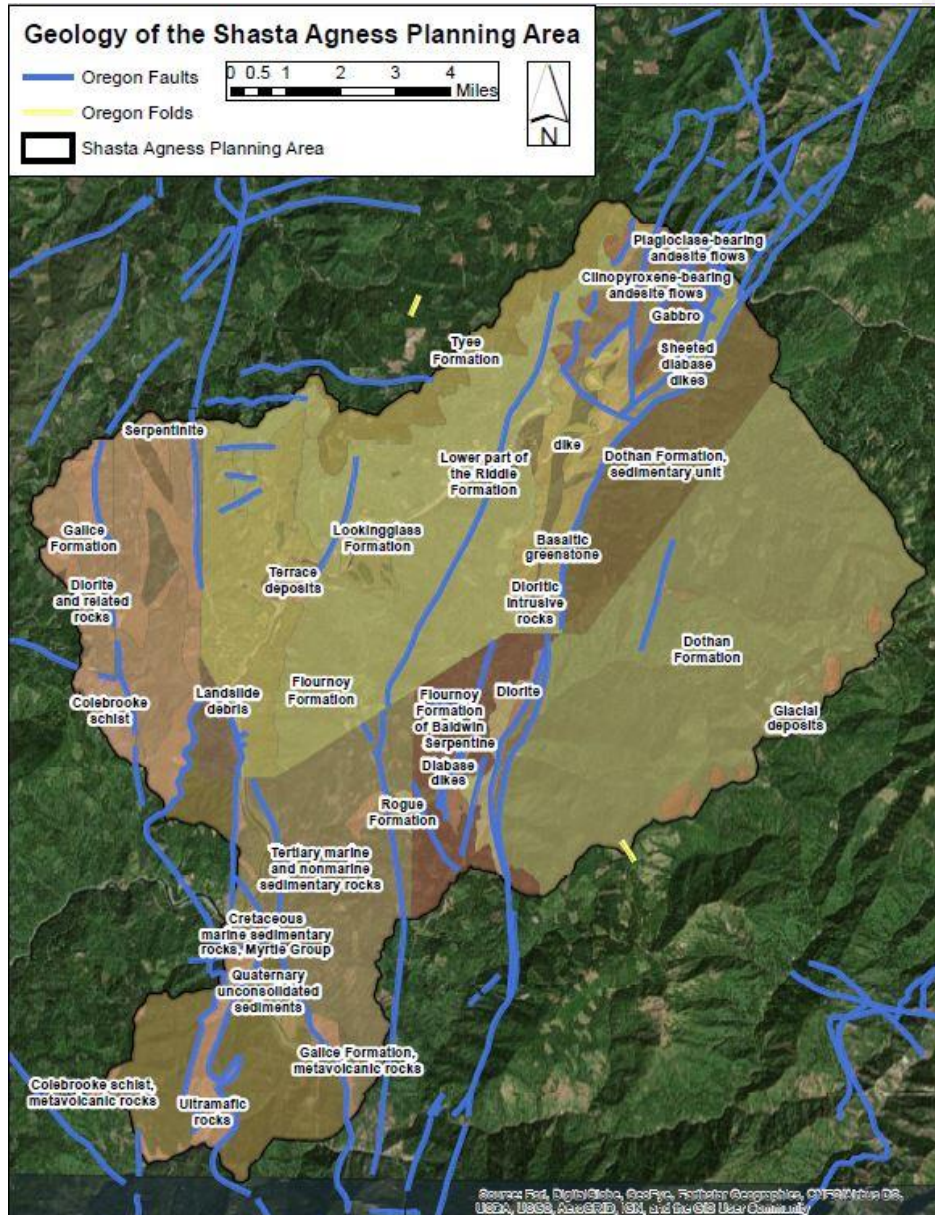
The Shasta-Agness Planning Area (SA) is within the Klamath Geologic Province. This is a very old accretion of volcanic and sedimentary rocks that have undergone tectonic activity, altering their physical and chemical characteristics (USDA Forest Service 1999). Our present-day landscape has been shaped over the last few million years through tectonic uplifting, faulting and shearing simultaneous with erosional and weathering processes. One result of these processes can be seen in wide shear zones between different types of rock. These shear zones can be recognized by folds or fractures in the rock, or by bands of serpentine. Faults and shear zones are typically areas of concentrated groundwater, more deeply weathered bedrock, and deeper soils. They are often related to the large, ancient, inactive or only periodically active landslides. In addition, faults and their associated bands of differing rock types, define the orientation of ridges and valleys. Diversity between resistances to erosion of the rock units has created a varied landscape and a steep, highly dissected topography. The geology in the area of the SA are further defined in the Lawson Creek Watershed Analysis (USDA Forest Service 1997), Rogue River Watershed Analysis, Marial to Agness (USDA Forest Service 1999), and Shasta Costa Creek Watershed Analysis (USDA Forest Service 1996). Figure 1 and Table 7 represent the formations and rock types.

Table 7. Shasta Agness Planning Area Geology Area Acres and Percent. (DOGAMI OGDC, 2009)

Formation or Rock Type	Acres Inside Shasta Agness Planning	Percentage of Shasta Agness Planning Area
Alluvial fan deposits	25	0.03%
Alluvium	129	0.14%
Basaltic greenstone	2572	2.79%
Clinopyroxene-bearing andesite flows	1492	1.62%
Colebrooke schist	665	0.72%
Colebrooke schist, metavolcanic rocks	63	0.07%
Cretaceous marine sedimentary rocks, Myrtle Group	6483	7.03%
Dacite to dacitic andesite flows	187	0.20%
Days Creek Formation	678	0.74%
Diabase dikes	116	0.13%
Dike	20	0.02%
Diorite	574	0.62%
Diorite and related rocks	168	0.18%
Dioritic intrusive rocks	1052	1.14%
Dothan Formation	21098	22.88%
Dothan Formation, sedimentary unit	5341	5.79%

Dothan Formation, volcanic rocks	388	0.42%
Dothan Formation, volcanic unit	11	0.01%
Flournoy Formation	14862	16.12%
Flournoy Formation of Baldwin	3560	3.86%
Gabbro	1114	1.21%
Galice Formation	4878	5.29%
Galice Formation, metavolcanic rocks	585	0.63%
Glacial deposits	585	0.63%
Landslide debris	186	0.20%
Lookingglass Formation	5918	6.42%
Lookingglass Formation of Baldwin	67	0.07%
Lower part of the Riddle Formation	386	0.42%
Muscovite granite	109	0.12%
Phyllite	58	0.06%
Plagioclase-bearing andesite flows	90	0.10%
Porphyritic andesite and basalt	428	0.46%
Quaternary unconsolidated sediments	996	1.08%
Rogue Formation	162	0.18%
Serpentine	120	0.13%
Serpentinite	25	0.03%
Sheeted diabase dikes	702	0.76%
Terrace deposits	449	0.49%
Tertiary marine and nonmarine sedimentary rocks	8293	8.99%
Tuffaceous deposits	181	0.20%
Tyee Formation	2724	2.95%
Ultramafic rocks	4668	5.06%
Grand Total	92207	100.00%

Figure 1. Geology of the Shasta Agness Planning Area. (DOGAMI OGDC, 2009)



The geologic setting found in the project planning area is highly diverse, with widely dissimilar rock types located adjacent to one another in complex faulted relationships as portrayed by Table 7 and Figure 1, therefore what will be discussed further in the report are the formations and rock types associated with the activities in the proposed action areas.

Narrative information below for the summaries of rock formations and descriptions have been excerpted from Watershed Analyses completed as per the Northwest Forest Plan.

Rogue River Watershed Analysis, Marial to Agness, 1999

Quaternary deposits (Qal): Geologically recent alluvial, terrace and landslide deposits consist of unconsolidated sand, silt, and gravels deposited by water or erosional processes. Mineralogy is dependent on the source material of the deposits, and in the case of ancient terraces along the Rogue River, can be a complex mixture of materials transported from far upstream. Soils tend to have minimal profile development with irregular concentrations of organic materials depending on the time intervals between flood scour and deposit, or landslide events. Through the mechanics of their deposition, Qal deposits form relatively flat slopes. However, because of their position on the slope and poor consolidation, they are prone to stability problems from undercutting by streams or roads, surface erosion, and slide re-initiation from groundwater saturation or runoff.

Tyee Formation (Tt): The Tyee Formation forms high, exposed bluffs of greenish-gray, clay-rich sandstones with interbeds of mudstone and siltstone. Bluffs formed by Tyee sandstone are prone to rock topple; boulders and cobbles can be found immediately downslope, but weather rapidly to sandsize constituents. Periodic slope failures are common where headwall areas are underlain by steep slopes of poorly cohesive sandstones and siltstones, and can initiate debris torrents in stream channels. Root strength and cohesion from forest vegetation helps to maintain the marginal stability of these headwalls. Tyee Formation is exposed in a small area of the watershed, notably in the headwaters of Billings Creek.

Tertiary marine sandstones and conglomerates (Tmsc): This unit includes the Roseburg, Umpqua, and Lookingglass Formations. The Roseburg Formation represents the oldest unit in this group. It is located along the Rogue River above Agness and can be identified in exposures of steeply dipping beds of sandstone and conglomerate. Slopes underlain by the Roseburg Formation are steep and sparsely vegetated, reflecting shallow, coarse-textured soils. Although relatively stable in the limited area in which the formation is exposed, steep slopes where soil is disturbed by road construction experience chronic, small, shallow debris slides and surface ravel.

The Lookingglass Formation also has limited exposure in the study area, mostly in the Billings Creek area. However, slopes underlain by Lookingglass rhythmically-bedded siltstones and mudstones are notable for several large landslides that have contributed large quantities of fine-grained sediment to Billings Creek and the Rogue River. On upper slopes, Lookingglass mudstones commonly form steep slopes protected by more resistant Tyee sandstone. On mid and lower slopes, the combination of less permeable mudstone layers and deep colluvial soils has produced large slump-earthflows that have constricted or deflected Billings Creek and the lower portion of Foster Creek numerous times in the past. Several of these large, old failures remain intermittently active, contributing sediment to the creek usually as debris slides off the toe of the moving slide mass. There are also areas in Billings Creek of older catastrophic debris flows which have formed relatively stable, lobate deposits above the creek. Several large block glides, another form of slope failure sometimes found in bedded rocks of differing permeability, were noted in the lower part of the watershed. These blocks probably failed in ancient times under a combination of more severe climatic conditions and seismic activity, and now appear to have

reached a stable configuration. Earthflow and slump blocks in the lower portion of Foster Creek have their own inherent instability compounded by the very extensive earthflow that encompasses the almost entire upper and middle Foster Creek watershed area.

Tertiary marine sandstone and siltstone (Tmss): In the analysis area, the Flournoy Formation consists of large expanses of siltstones with minor sandstone and conglomerate beds. It is exposed in the lower part of the Shasta Costa watershed, and is described in the Shasta Costa Creek Watershed Analysis, 1996. Massive conglomerate beds are well exposed along the Rogue River canyon above Flora Dell Creek through Foster Bar. The basal conglomerate beds of the Flournoy closely resemble conglomerate beds found within the Lookingglass Formation. Geologic maps and formation descriptions are not in agreement through this section of the river. Soil types reflect age of soil development. Young soils, which form on steep slopes, are shallow, silty, and poorly cohesive; soils on flatter and/or lower slopes are deeper and more clay-rich. Slope failure types correspond to this soil development. Shallow debris slides, debris torrents, and ravel predominate along areas of shallow contacts between bedrock and soil, and deep-seated rotational slides occur in older, thicker soils. Streambank instability is common in the inner gorge of Shasta Costa Creek, where stream action undercuts older, landslide deposits or erodes exposed bedrock of Flournoy siltstones.

Dothan sandstone and conglomerate (KJds): The Jurassic-Cretaceous aged Dothan Formation underlies the eastern portion of the analysis area, primarily in the Shasta Costa Creek watershed. Descriptions of geology, soils and erosional processes are included in the Shasta Costa Creek Watershed Analysis, 1996. In this area, the formation consists of well-consolidated sandstones, with less extensive, poorly sorted siltstones and rare volcanic flow units, all of which have undergone low-grade metamorphism. The predominant north-east structural trend is reflected in the trends of major drainages, ridges, and rock units. Geomorphology is consistent with underlying rock type; sandstones form steep, rocky ridgetops, and siltstones and mudstones develop rolling, hummocky slopes and prairies. Soils are generally moderately deep to deep, and landforms are stable in configuration. Exceptions occur along streambanks of the inner gorge of Shasta Costa Creek and tributary stream channels where undercutting has oversteepened deep soils on the lower slopes. Also notable are extensive slump-earthflows that have developed in deep, clay-rich and poorly drained soils in areas where Dothan mudstones are more common. Three large, chronically active slump-earthflows on the north side of Shasta Costa Creek have deflected the stream and also periodically offset Forest Service Road 23. A large slump or rotational slide was noted in the headwaters of Waters Creek within the Dothan Formation, and contiguous to faulted contacts between Dothan, Galice and serpentine rocks.

Galice medium- to fine-grained sedimentary rocks (Js): Rocks in the Galice formation are exposed in the far, western portion of the analysis area, from Foster Creek watershed and south. These sedimentary rocks have undergone some low-grade metamorphism, and are also more fractured and faulted than in other areas outside the analysis area underlain by this laterally extensive formation. Soils formed on Galice formation rocks are shallow to moderate in depth, or rocky, skeletal soils where slopes are steep. Steep slopes will form areas of ravel when disturbed, although deeper slump earthflows can also be seen within the Galice rocks. Frequently, those slump earthflows are found along faults and their associated shear zones, such as noted above in Waters Creek.

Galice metavolcanics (Jv) and metagabbro and diorite (JTrgd): This formation consists of primarily volcanic flow rocks (basalt to rhyolite) with some interlayered tuffs. The unit has undergone low-grade metamorphism, which has increased the hardness and resistance to erosion of these already resistant rock types. Areas underlain by Galice volcanics form the steepest

slopes in the analysis area, and stand out as a broad, north-east trending band in the top center of the Slope Classes map. These resistant rocks underlie the sharp peaks at Inspiration Point and Pinnacle Peak, and the spectacular, steep walls of Mule Creek Canyon. This hard rock unit retains many of the topographic breaks from ancient faulting and fractures, and forms many of the most challenging falls and rapids on the Rogue River. The zone is also highly mineralized, and was a concentration for gold mining activities in the late 1800s.

Soils derived from these metamorphosed volcanic and intrusive rocks are typically shallow, usually forming from talus deposits off steep cliff faces, and have poor to moderate cohesion. The most common form of instability noted from a survey of aerial photos was shallow ravel. Debris torrents and stream scour can occur where soils are disturbed and fail from steep headwalls. Revegetation on these skeletal soils happens very slowly.

Peridotite, serpentine, ultramafics (Ju): Limited bodies of serpentine and serpentinized peridotite occur in the area; they are grouped on the geologic map as ultramafic rocks. The peridotite probably originated as lower ocean crust which was subsequently metamorphosed to serpentine minerals during faulting and accretion onto the continent. In the analysis area, the ultramafics occur concomitantly with fault and fracture zones, exposed along the Rogue River in the Pinnacle Peak area faulted against Galice metavolcanics. The ultramafic bands follow the general north-east structural trend.

Soils derived from peridotite and serpentine are commonly shallow in depth, reddish, and nutrient-poor, and characterized by a high clay content and plasticity. Where shallow soils are physically disturbed, surface ravel, the slow process of revegetation in serpentine soils can perpetuate compaction, rilling and gullying. Deeper soils are often formed in faulted areas that are zones of sheared rock and conduits for ground water. These conditions can develop into failure planes for earthflows, or localized pockets of slope instability.

Metagabbro, diorite and metavolcanics (JTrgd): The oldest rocks in the analysis area are the ultramafic rocks and the metamorphosed igneous rocks, which represent middle and upper ocean crust material, metamorphosed during accretion. The rock is relatively hard and resistant to erosion where protected, often forming small vertical exposures. When exposed to weathering, however, it decomposes readily, although appearing fresh in appearance at exposed rock faces. Soils derived from these rocks are typically shallow, coarse-grained, porous and non-cohesive. Shallow soils are prone to ravel. When saturated, deep soils or deposits can produce an abrasive fluid mixture. Therefore, debris torrents, initiated from bluffs or cliffs, disturbed steep slopes, or along road cuts and fills, can travel long distances scouring hillsides and stream channels.

Shasta Costa Creek Watershed Analysis, 1996

The Shasta Costa watershed can roughly be divided into three sections: the upper section has rocks of Dothan Formation, the middle section is a narrow band of diorites and metavolcanics, and the lower section consists of rocks of the Flournoy and Lookingglass Formations and the Undifferentiated Umpqua Group; all tertiary in age. These are described in detail above in the Rogue River Watershed Analysis, Marial to Agness (USDA Forest Service 1999).

Lawson Creek Watershed Analysis, 1997

The planning area contains the lower portion of the Lawson Creek Watershed, approximately 10,638 acres. The rock types found within this proportion of the planning area are primarily Colebrooke Schist, ultramafic and volcanic rocks, and Cretaceous marine sedimentary rocks.

Colebrooke schist usually develops rolling, moderate topography. Slopes tend to form benches due to differential weathering. Soils in Colebrooke Schist are generally deep on moderate slopes, thin to medium on ridgetops, and thin and rocky in steeper inner gorges and tributary headwalls. The schist can be subject to deep failure when oversteepened (Ferraro, 1990). Cretaceous sedimentary rocks are of limited extent in the project area occurring in the south portion of the planning area along the Illinois River. In this area, the Cretaceous sedimentary rocks consist of massive cobble and pebble conglomerates with subordinate coarse sandstone beds (Busby and Bestland 1992). These conglomerates form large cliffy bluffs along the Illinois River. Areas of volcanic rocks tend to be stable but are prone to ravel. These rocks tend to be resistant to erosion and commonly form topographic highs. Soils on volcanic rocks are typically shallow.

B. Soils

The soils in the planning area are developing from various geologic parent material and landform associations (see Figure 2). The landform associations from which soils are forming include: Angulate Mountains; Cirque Basins and Icefields; Collapsed Broadcrested Mountains; Collapsed Broadcrested Mountains, Serpentinitic; Dissected Broadcrested Mountains; Dissected Broadcrested Mountains, Serpentinitic; Smoothcrested Mountains; Stratal Mountains; Verrucated Mountains; and Verrucated Mountains, Serpentinitic. The terrain is classified as mountains, which are further defined based on morphology, including the pattern and density of drainages, depth of drainages, overall morphology of the area between the drainages, evidence of a strong imprint of a surficial process such as glaciation, and presence of visible underlying rock structure (ECOSHARE 2017).

The climate of the Rogue River basin varies because of its steep topography and interception of moisture from the Pacific Ocean (USDA Forest Service 1999). The average annual precipitation ranges from 70 to 190 inches, predominantly as rain in the winter. Near the coast, cool and humid weather prevails throughout the year. Farther upstream, the effects of the marine climate are less pronounced and the weather is often hot and dry during the summer (USDA Forest Service 1999). Elevations range from approximately 170 feet on the Rogue River near Agness to 5,298 feet at Brandy peak.

Soils have been mapped by the USDA Natural Resources Conservation Service, formerly known as the Soil Conservation Service. The soils information in the Coos and Curry County Soil Survey (NRCS 1995) (including soils information accessed in Web Soil Survey) was used for field verification and analysis in this report. Figure 3 displays the soil map units within the Planning Area, and further descriptions of the soil map unit characteristics and management limitations can be found in Table 8 and Appendix 1 and 2 of this report.

Further review of the soils using the Official Soil Series Description online database have classified the soils orders within the planning area as Alfisols, Inceptisols, Mollisols, and Ultisols. Alfisols are soils that are moderately weathered. Within the project area alfisols have formed under a mixed hardwood (black oak and pacific madrone) and an open grown mixed conifer (ponderosa pine and Douglas-fir) forest cover. They have a clay-enriched subsoil and are relatively fertile. Ultisols are soils that contain high amounts of clay, also known as red clay soils, in the subsoil layers due to their development in humid areas and temperate climates. They have undergone intense weathering, and due to their acidity fertility is limited. Mollisols are often known by their dark-colored surface horizon formed by the consistent addition of organic matter because they develop in grasslands or prairies. Due to the high content of organic matter soils are highly fertile. However, they are found in drier climate regimes. Inceptisols are soils that have not undergone intense weathering or accumulation of clays in the subsurface. They can form in a wide variety of climatic conditions and rock types.

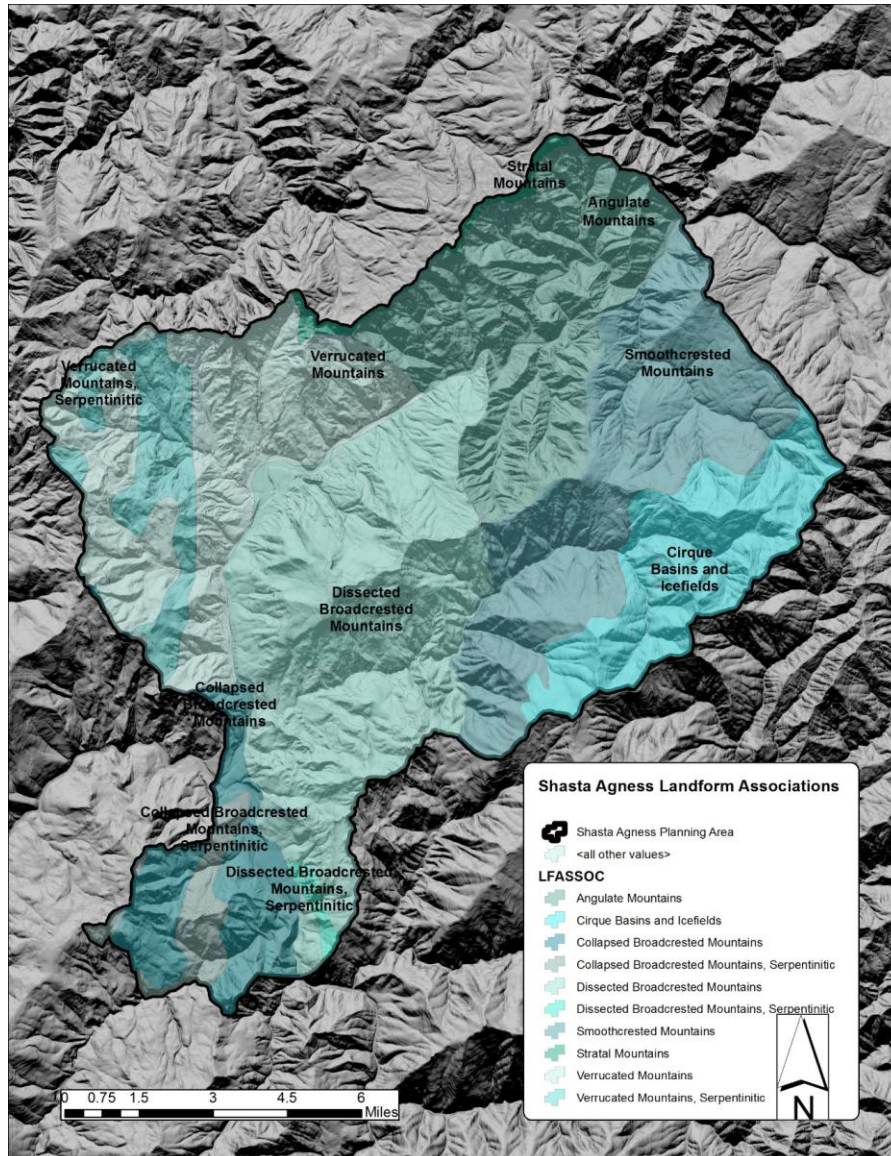
Serpentinic soils in the planning area are those that are forming in ultramafic peridotite/serpentinite parent geologies. These soils are droughty due to high rock content and are very low in fertility. Due to the mineralogy of the parent rock, the soils have a very high content of magnesium and are very low in calcium, which limits plant growth.

Asbestos is a term used for several types of fibrous minerals that occur naturally in the environment. Naturally occurring asbestos (NOA) is commonly found in serpentinite and other ultramafic rock formations, as well as the soils where these rock types are located. Not all of these rock formations, however, contain NOA; they only have the potential to contain asbestos, and require environmental testing to determine presence.

Asbestos minerals fall into two general categories – chrysotile (also known as serpentine asbestos) and amphibole. Chrysotile and two amphibole minerals, tremolite and anthophyllite, have been found in Oregon, and are associated with serpentine (Bright and Ramp 1965; Van Gosen 2010). The Klamath Mountains Province contains intrusions of serpentine along faults and geologic contacts, as well as peridotite that has been exposed through tectonic uplift and altered to serpentine minerals.

Information as to the levels of asbestiform minerals in serpentine soils on the forest is very limited. A laboratory study of two soil pedons associated with serpentine parent material, Snowcamp and Serpantano, was conducted in 1994 by the USDA Soil Conservation Service. Results for the Snowcamp pedon were negative for the presence of asbestiform minerals. The Serpantano pedon was determined to have less than one percent asbestiform minerals in the 2C2 and 2CR horizons (Burt 1994). There are about 5,799 acres of ultramafic soils within the planning area (or about 6% of the overall acres).

Figure 2. Landform Associations of the Shasta Agness Planning Area.



[illegible]

1. Available Water Storage and Resilience to Drought

Available water storage (AWS) or available water capacity (AWC) refers to the quantity of water that the soil is capable of storing for use by plants (NRCS 2016). It is limited by inherent soil characteristics including soil depth, rock content, texture, and bulk density, as well as influenced by organic matter content. Water storage can be affected by management activities that erode soil, increase bulk densities (i.e. compact the soil, resulting in a loss of pore space), and reduce soil organic matter content. Utilizing available soil survey data, Oregon State University, in cooperation with Region Six of the U.S. Forest Service, created a map displaying the inherent soil water holding capacities of soils in Oregon and Washington, based on the dominant soils in soil map units. AWS is an important indicator of soil productivity because soils with high AWS will generally have more favorable growth conditions, on the contrary, low AWS will have less favorable plant growth conditions.

A large portion of soils in the Shasta Agness planning area exhibits low inherent capacity for AWS. When precipitation is not a limiting factor, such as during an average wet season, or during exceptionally wet years, then despite the inherently droughty nature of the soils, vegetation have access to enough water and there is less competition for this normally limiting resource. However in the Mediterranean climate that is in Southern Oregon, with typically warm, dry summer months, water often becomes a limiting factor during the warm portion of the year. During drought cycles, competition for scarce available water on inherently droughty slopes typically results in vegetation stress and resultant mortality, which becomes exacerbated by stands that have grown denser during wet periods and from suppression of regular wildfire disturbance.

Moderate and high water holding capacity is observed trending from north to south along the Rogue and Illinois River corridors. In addition, an area is located in the eastern portion of the planning area. Soils exhibiting moderate and high AWS are generally deeper and finer textured soils found in the valley bottoms and immediate toe slopes. These soils have the inherent capacity to hold more available water for plant uptake, for a longer period of time throughout the year. They have a little more resiliency to buffer the effects of drought cycles, though competition between vegetation in stands that have grown up with the suppression of regular wildfire disturbance can still result in stress and mortality during drought periods.

C. Soil Productivity

Table 8 displays the relative sensitivities of each of the soils found within the natural stand treatment units in the Planning Area to disturbance based off of various soil properties (refer the appendices for soil map units found within each stand for the project area) (Web Soil Survey: <http://websoilsurvey.nrcs.usda.gov/>). The disturbance sensitivities of candidate natural stands (oak, serpentine pine, and sugarpine) were of particular interest in relation to other treatment activities because no prior entry of commercial harvest has occurred, and therefore the potential to cause greater impacts compared to other treatment activities was of concern.

Though for further information on candidate plantation soils and the soil restoration potential of each soil map unit refer to: *Appendix 1: Soil Characteristics and the Mangement Limitations of Silviculture Activities*. In addition, reference, *Current Conditions and Past Forest Management Activities and their Influence on Soil Characteristics*, to learn about treatment units containing historic commercial harvest entry (i.e. candidate plantations) within the Shasta Agness planning area.

Table 8. Sensitivities of Oak Savannah and Pine Soils in the Planning Area to Selected Disturbances.

Map Unit	Site Degradation Susceptibility	Harvest Equipment Operability	Soil Compaction Resistance	Soil Rutting Hazard	Erosion Hazard (Road/Trail)	Erosion Hazard (Off-Road, Off-Trail)	Fire Damage Susceptibility	Soil Restoration Potential
1B	Slightly susceptible	Well suited	Moderate resistance	Slight	Slight	Slight	Moderately susceptible	High Potential
8E	Moderately susceptible	Moderately suited	Moderate resistance	Slight	Severe	Moderate	Moderately susceptible	High Potential
9F	Highly susceptible	Poorly suited	Moderate resistance	Slight	Severe	Severe	Highly susceptible	High Potential
9G	Highly susceptible	Poorly suited	Moderate resistance	Slight	Severe	Very severe	Highly susceptible	High Potential
22F	Highly susceptible	Poorly suited	Moderate resistance	Moderate	Severe	Severe	Highly susceptible	High Potential
23G	Highly susceptible	Poorly suited	Moderate resistance	Moderate	Severe	Very severe	Highly susceptible	High Potential
25G	Highly susceptible	Poorly suited	Moderate resistance	Moderate	Severe	Very severe	Highly susceptible	High Potential
28F	Highly susceptible	Poorly suited	Moderate resistance	Moderate	Severe	Severe	Highly susceptible	High Potential
31F	Highly susceptible	Poorly suited	Moderate resistance	Moderate	Severe	Severe	Highly susceptible	High Potential
33E	Moderately susceptible	Well suited	Moderate resistance	Moderate	Moderate	Moderate	Moderately susceptible	High Potential
53D	Moderately susceptible	Moderately suited	Moderate resistance	Slight	Severe	Moderate	Moderately susceptible	High Potential
53E	Highly susceptible	Poorly suited	Moderate resistance	Slight	Severe	Very severe	Highly susceptible	High Potential
53F	Highly susceptible	Poorly suited	Moderate resistance	Slight	Severe	Severe	Highly susceptible	High Potential
54F	Highly susceptible	Poorly suited	Moderate resistance	Slight	Severe	Severe	Highly susceptible	High Potential
56F	Highly susceptible	Poorly suited	Moderate resistance	Slight	Severe	Severe	Highly susceptible	High Potential
61A	Moderately susceptible	Well suited	Moderate resistance	Moderate	Slight	Slight	Moderately susceptible	High Potential

Gold Beach Ranger District, Rogue River-Siskiyou National Forest

74F	Highly susceptible	Poorly suited	Moderate resistance	Slight	Severe	Severe	Highly susceptible	High Potential
80F	Highly susceptible	Poorly suited	Moderate resistance	Slight	Severe	Severe	Highly susceptible	High Potential
88F	Highly susceptible	Poorly suited	Moderate resistance	Slight	Severe	Severe	Highly susceptible	High Potential
90E	Moderately susceptible	Moderately suited	Moderate resistance	Severe	Severe	Moderate	Moderately susceptible	High Potential
91F	Highly susceptible	Poorly suited	Moderate resistance	Slight	Severe	Severe	Highly susceptible	High Potential
91G	Highly susceptible	Poorly suited	Moderate resistance	Slight	Severe	Very severe	Highly susceptible	High Potential
104 E	Moderately susceptible	Well suited	Moderate resistance	Slight	Severe	Moderate	Moderately susceptible	High Potential
105F	Highly susceptible	Poorly suited	Moderate resistance	Slight	Severe	Severe	Highly susceptible	High Potential
112 A	Slightly susceptible	Moderately suited	Moderate resistance	Severe	Slight	Slight	Slightly susceptible	High Potential
119 A	Slightly susceptible	Well suited	Low resistance	Moderate	Slight	Slight	Slightly susceptible	High Potential
132F	Highly susceptible	Poorly suited	Moderate resistance	Slight	Severe	Severe	Highly susceptible	High Potential
133 G	Highly susceptible	Poorly suited	Moderate resistance	Slight	Severe	Very severe	Highly susceptible	High Potential
147 E	Moderately susceptible	Well suited	Moderate resistance	Moderate	Severe	Moderate	Moderately susceptible	High Potential
158F	Highly susceptible	Poorly suited	Moderate resistance	Slight	Severe	Severe	Highly susceptible	High Potential
159F	Highly susceptible	Poorly suited	Moderate resistance	Slight	Severe	Severe	Highly susceptible	High Potential
176F	Highly susceptible	Poorly suited	Moderate resistance	Slight	Severe	Severe	Highly susceptible	High Potential
182F	Highly susceptible	Poorly suited	Moderate resistance	Severe	Severe	Severe	Highly susceptible	High Potential
196 C	Slightly susceptible	Moderately suited	Low resistance	Severe	Severe	Slight	Slightly susceptible	High Potential
196 D	Moderately susceptible	Moderately suited	Low resistance	Severe	Severe	Moderate	Moderately susceptible	High Potential
197 E	Moderately susceptible	Well suited	Moderate resistance	Severe	Severe	Moderate	Moderately susceptible	High Potential
211 G	Highly susceptible	Poorly suited	Moderate resistance	Moderate	Severe	Very severe	Highly susceptible	High Potential
212 G	Highly susceptible	Poorly suited	Moderate resistance	Moderate	Severe	Very severe	Highly susceptible	High Potential
221 B	Slightly susceptible	Moderately suited	Moderate resistance	Severe	Moderate	Slight	Moderately susceptible	High Potential
221 D	Moderately susceptible	Moderately suited	Moderate resistance	Severe	Severe	Moderate	Moderately susceptible	High Potential
230 E	Moderately susceptible	Well suited	Moderate resistance	Slight	Severe	Moderate	Moderately susceptible	High Potential
232F	Highly susceptible	Poorly suited	Moderate resistance	Slight	Severe	Severe	Highly susceptible	High Potential
233F	Highly susceptible	Poorly suited	Moderate resistance	Slight	Severe	Severe	Highly susceptible	High Potential
234F	Highly susceptible	Poorly suited	Moderate resistance	Moderate	Severe	Severe	Highly susceptible	High Potential
240 E	Moderately susceptible	Well suited	Moderate resistance	Slight	Moderate	Moderate	Moderately susceptible	High Potential

241 E	Moderately susceptible	Well suited	Moderate resistance	Slight	Moderate	Moderate	Moderately susceptible	High Potential
242 G	Highly susceptible	Poorly suited	Moderate resistance	Slight	Severe	Very severe	Highly susceptible	High Potential
264F	Highly susceptible	Poorly suited	Moderate resistance	Slight	Severe	Severe	Highly susceptible	High Potential
267F	Highly susceptible	Poorly suited	Moderate resistance	Moderate	Severe	Severe	Highly susceptible	High Potential
279 E	Moderately susceptible	Well suited	Moderate resistance	Slight	Moderate	Moderate	Moderately susceptible	High Potential

The following paragraphs give a brief explanation of each rating, summarized from the Descriptions in the Web Soil Survey. Refer to the complete descriptions at the Web Soil Survey site for more detail.

- **Site Degradation Susceptibility:** Rates each soil for its susceptibility for soil degradation to occur during disturbance, seen conversely is the soil's buffering capacity to resist change. Ratings represent relative risk of water and wind erosion, salinization, sodification, organic matter and nutrient depletion and /or redistribution, and loss of adequate rooting depth.
- **Harvest Equipment Operability:** Rates each soil for its suitability of forestland harvesting equipment. The ratings are based on slope, rock fragments on the surface, plasticity index, content of sand, the Unified classification of the soil, depth to a water table, and ponding. Standard rubber-tire skidders and bulldozers are assumed to be used for ground-based harvesting and transport. "Well suited" indicates that the soil has features that are favorable for the specified management aspect and has no limitations. Good performance can be expected, and little or no maintenance is needed. "Moderately suited" indicates that the soil has features that are moderately favorable for the specified management aspect. One or more soil properties are less than desirable, and fair performance can be expected. Some maintenance is needed. "Poorly suited" indicates that the soil has one or more properties that are unfavorable for the specified management aspect. Overcoming the unfavorable properties requires special design, extra maintenance, and costly alteration.
- **Soil Compaction Resistance:** Rates each soil for its resistance to compaction, which is predominantly influenced by moisture content, depth to saturation, percent of sand, silt, and clay, soil structure, organic matter content, and content of coarse fragments.
- **Soil Rutting Hazard:** This rating indicates the hazard of surface rut formation through the operation of forestland equipment. Soil displacement and puddling may occur simultaneously with rutting. "Slight" indicates soil is subject to little or no rutting; "Moderate" indicates rutting is likely; "Severe" indicates that ruts form readily.
- **Erosion Hazard (Road/Trail):** Ratings indicate the hazard of soil loss from un-surfaced roads and trails. Ratings are based on soil erosion factor K, slope, and content of rock fragments. "Slight" indicates that little or no erosion is likely; "Moderate" indicates some erosion is likely, and roads/trails may require occasional maintenance, and that simple erosion-control measures are needed; "Severe" indicates that erosion is expected, roads/trails require frequent maintenance, and costly erosion-control measures are needed.
- **Erosion Hazard (Off-Road, Off-Trail):** Ratings indicate the hazard of soil loss from off-road and off-trail areas after disturbance activities that expose the soil surface. Ratings are based on slope and soil erosion factor K, with soil loss caused by sheet or rill erosion where 50 to 75 percent of the surface has been exposed by logging, grazing, mining, or other kinds of disturbance.
- **Fire Damage Susceptibility:** Ratings indicate the relative risk of creating a water repellent layer, volatilization of essential soil nutrients, destruction of soil biological activity, and vulnerability to

water and wind erosion prior to reestablishing adequate watershed cover on the burned site. The ratings are directly related to burn severity (e.g. a low-moderate severity burn will not result in water repellent layer formation). This rating should be used in conjunction with the rangeland seeding ratings or the soil restoration potential rating depending upon whether seeding or natural regeneration will be utilized on the site. Rating class terms indicate the extent to which the soils are limited by all of the soil features that affect soil damage by fire. "Highly susceptible" indicates that the soil has one or more features that are very favorable for soil damage by fire. "Moderately susceptible" indicates that the soil has features that are moderately favorable for damage to occur. "Slightly susceptible" indicates that the soil has features that generally make it unfavorable for damage to occur.

- **Soil Restoration Potential:** Rates each soil for its inherent ability to recover from degradation (i.e., soil resilience). Soil resilience is dependent upon adequate stores of organic matter, good soil structure, low salt and sodium levels, adequate nutrient levels, microbial biomass and diversity, adequate precipitation for recovery, and other soil properties.

Overall, soils within candidate natural stands for the Shasta Agness Planning Area are sensitive to disturbances that can have an adverse effect to soil productivity. Interestingly, each soil is rated as **high potential**, indicating an inherent ability to recover well from these disturbances, either naturally or through implementation of restoration activities. This has been apparent in field reviews throughout the Shasta Agness project area looking at the residual effects of past actions, discussed in the *Current Condition and Past Forest Management and their Influence on Soil Characteristics* Assessment, below.

D. Current Conditions and Past Forest Management Activities and their Influence on Soil Characteristics

The Shasta Agness Planning Area was historically utilized for various human uses. Human activities affecting erosion processes included: gold mining, livestock grazing following large wildfires, road construction, and commercial logging. The rate of management-related slope failures between 1969 and 1986 increased in direct proportion to the amount of road building, tractor-yarded clear-cut timber harvest, and logging in and through stream channels and swales (USDA Forest Service 1999).

In addition to failures, past forest management activities have affected soils in the project planning area through compaction, displacement, removal of organic matter, burning, and erosion. Based on agency records, approximately 8,257 acres (9 percent) of the project planning area has had previous vegetation management treatments.

Field reviews looking at soil condition from past human activities and natural processes were conducted through the Planning Area, particularly focusing on proposed candidate stands, aquatic habitat restoration treatments, and sustainable road treatment activities. Within sites assessed the most noted evidence of instability were landslides associated with the current road system or slump-earthflows along steep inner channels of streams such as in Billings, Shasta Costa, and Snout Creek. Failures related to existing road system are expected to continue adding sediment to streams, although as stability problems are identified and either reconstructed, stormproofed, or decommissioned the level of disturbance will greatly decrease. Figure 4 is an example of a landslide failure on NFS Road 2300860, currently proposed for decommissioning in Alternative 1.

Figure 4. Landslide failure on NFS Road 2300860 proposed for decommissioning.



Prior to the 1989 Siskiyou National Forest Land and Resource Management Plan, harvest and site preparation operations were conducted without present day standards and guidelines. Harvesting equipment may have had no restrictions on where to operate or under what soil moisture conditions. Historical management practices utilized heavy equipment and methods which often resulted in detrimental impacts to the soil beyond what would be allowed today. Areas that were harvested during wet conditions in these soils may have resulted in detrimental compaction, displacement, and surface erosion.

Within the stands, outside of the prior disturbance footprints from landings, skid trails, and road grade impacts, no detrimental disturbance still measurably affecting site productivity was found. Decomposing organic litter is providing a consistent blanket across the forest floor to protect surface soils from erosion. Occasional evidence of soil displacement from multiple passes along primary skid trails were found, but soil pits and shovel resistance tests, as well as observation of vegetation cover, did not indicate a measureable difference inside and outside of that past direct disturbance from the 1960s and 1970s. In addition, **Appendix 1, Table 20** describes the Soil Restoration Potential for most these soils as *high*, which agrees with the observations during field reconnaissance. Moreover, these field observations validate the resiliency these soils have to disturbance and their ability to recover naturally over time when given the opportunity.

Table 9 summarizes the existing soil conditions of proposed silvicultural treatment units (candidate plantations) associated with late-seral development. Table 10 summarizes the past management history for all the proposed candidate stands (oak, pine, and candidate plantations). Past management history was determined through agency records and review of low elevation

1994 to present day aerial photos on Google Earth (see Figure 5, Figure 6, and Figure 7). In addition, monitoring was conducted for 14 plantation units for the Upper Briggs Restoration Project in 2016 using the Forest Soil Disturbance Monitoring Protocol rapid assessment (Page-Dumroese et al. 2009 and J. Brazier, Pers. Comm.). This data was used as a surrogate to predict and compare what may occur in the Shasta Agness planning area under the different alternative scenarios. Comparison of total detrimental soil disturbance, which is characterized by similar soil and treatment characteristics, have been reviewed to compare and contrast existing conditions in the project area as well. Evaluation of existing conditions indicated similar results to what was observed within the Shasta Agness planning area. From the data review of agency records, aerial photographs, and comparison of the Upper Briggs Restoration Project- predominantly, low to moderately low soil disturbance was detected throughout candidate plantations, however in soils characterized by fine and loamy textures developed within Inceptisols, ratings were taken as detrimentally impaired, because the proportion of the unit detrimentally impacted exceeded SLRMP soil standards (15%, including roads and landings). Past management indicated clear cuts were the main prescription used in harvest activities, most occurring in the 1960s and 1970s; however plantation unit 215, approximately 14 acres, received harvest partial removal (HPR) dating back to the late 1960s. A potential for soil restoration activities exists in areas that have had past management.

For the proposed silvicultural and natural fuels treatment units in the Shasta Agness planning area, the percent of area that was found to be detrimentally compacted, puddled, or displaced were identified on 1 inch = 400 to 600 feet scale aerial photographs, as well as reviewing historic NAIP satellite imagery in Google Earth. Roads, skid trails, and landings were measured in Google Earth, using the 1 inch = 400 to 600 feet scale photos as a guide. This method was not uniformly reliable as the canopy cover, where dense, would occlude the view. However, these combined approaches were selected as the most reasonable, cost effective, and scientifically sound process available.

Candidate plantation units 217, 218, 233, and 236 (Bearcamp12) exhibited residual disturbance that exceeds the Forest Plan standards and guides for no more than 15 percent detrimental disturbance. In these units in particular, design criteria and mitigations for activities require that no new disturbance occur, and to mitigate through activities to restore soils in the stand, such as subsoiling to break up compaction. In addition, other stands that are approaching 15 percent, such as units 209, 226, 227, 237, 241, and 254, are encouraged to re-use residual disturbed areas, such as legacy skid trails, as much as possible to minimize increase in detrimental soil disturbance.

Table 9. Estimated soil detrimental disturbance from past forest management activities within candidate plantation units.

Candidate Plantation Unit	Soil Map Unit	Percent in detrimental compacted, displaced, burned, or eroded areas
201	88F 104E 132F 132F	0
202	9F	4
203	8E 9F 9F 104E 132F	2
204	22F 8E 197E 85F	7
205	85F	4

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	198E	
206	85F	4
207	198E 85F 201F	4
209	13G	10
210	158F 233F 13G	6
211	233F 99E 25G	6
212	233F	4
213	35G 21F 99E 158F 20E	3
214	21F 5F 20E	6
215	21F 5F	0
216	21F 5F 124E 265F	3
217	265G 124E	29
218	21F 20E 35G 124E	16
219	159F 9G	4
220	21F 20E	6
221	175G 250F	1
222	124E 35G 239G 265G 265F	6
223	20E 250F	3
224	20E 155F 250F 265F	5
225	110E	2
226	110E	12
227	110E 109F 110D	11
228	110E 109F	1
229	110E 109F	6
230	175G 110E	4
231	108F 176G 91G 110E	3
232	108F	5
233	110E 108F	25

Gold Beach Ranger District, Rogue River-Siskiyou National Forest

	174F	
234	110E 251F 108F 174F	4
235	110E 251F 174F	5
236(BEARCAMP12)	20E 265F 244G 250F	16
236(STAIRCCK7)	174F 91G	3
237	20E 174F 250F 155F 250F	11
238	124E 265F	9
239	244G 250F	6
240	245G 265G 124E	7
241	265G	10
242	245G 265G	6
243	245G	5
244	245G 140F	4
245	245G 140F	7
246	245G 140F	4
248	156G 5F 35G 21F	3
249	156G 5F	2
250	156G 35G 140F 21F	1
251	140F 21F 265F	8
252	156G 21F	3
253	265G 156G 140F	4
254	140F	10
255	265F 21F 140F	8

Table 10. Vegetation management history within Shasta Agness Project units.

Management history	Proposed Shasta Agness silvicultural and fuel treatment units
No past commercial timber harvest management history	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 23, 29, 33, 39, 50, 51, 52, 53, 54, 55, 57, 58, 62, 59, 60, 61, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 101, 102, 102, 110, 111, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 123, 124, 125, 150, 151, 152, 153, 154, 155, 157, 158, 159, 270, 271, 272, 273, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 285, 286, 287, 288, 289, 302, 303, 304, 305, 306, 307, 308, 309, 310, 311, 312, 313, 314, 315, 316, 317, 318, 319, 320, 321, 322, 324, 325, 330, 331, 332, 333, 334, 335, 336, 337, 338, 339, 350, 351, 352, 353, 354, 360, 361, 362, 363, 364, 370, 371, 372, 373, 375
Past management history clear cuts	201, 202, 203, 204, 205, 206, 207, 209, 210, 211, 212, 213, 214, 216, 217, 218, 219, 220, 221, 222, 223, 224, 225, 226, 227, 228, 229, 230, 231, 232, 233, 234, 235, 236, 237, 238, 239, 240, 241, 242, 243, 244, 245, 246, 248, 249, 250, 251, 252, 253, 254, 255
Past management history harvest partial retention	215

Figure 5. 1940 aerial image of Candidate Plantation, Unit 211 before harvest.

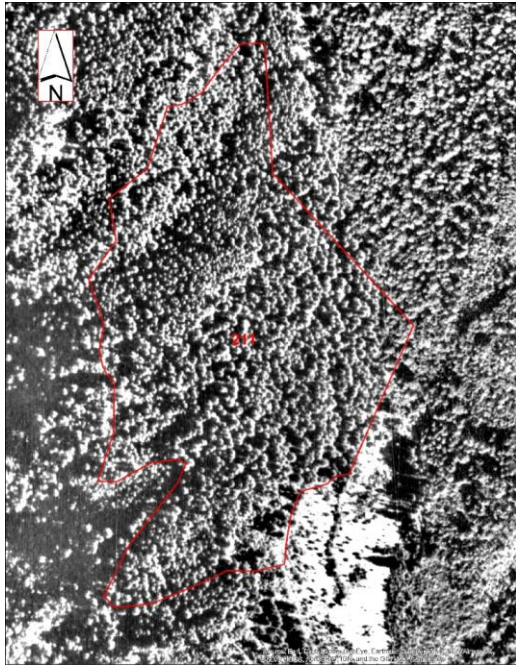


Figure 6 and 7. Oblique view looking North at Candidate Plantation, Unit 211 from 1994 and 2016 Google Earth aerial images. Red and crossed lines represent the estimated soil detrimental disturbance from past management activities. Yellow line represents the Shasta Agness planning area boundary. Blue lines represent streams.

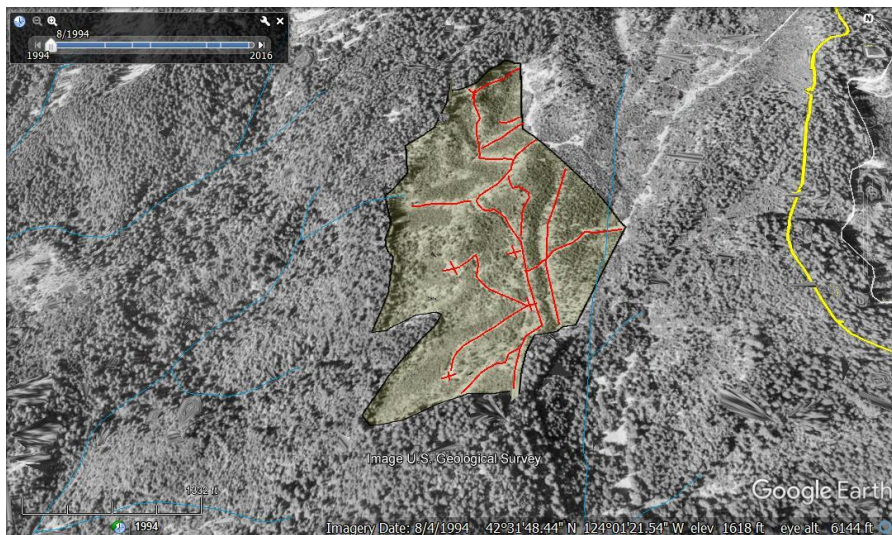
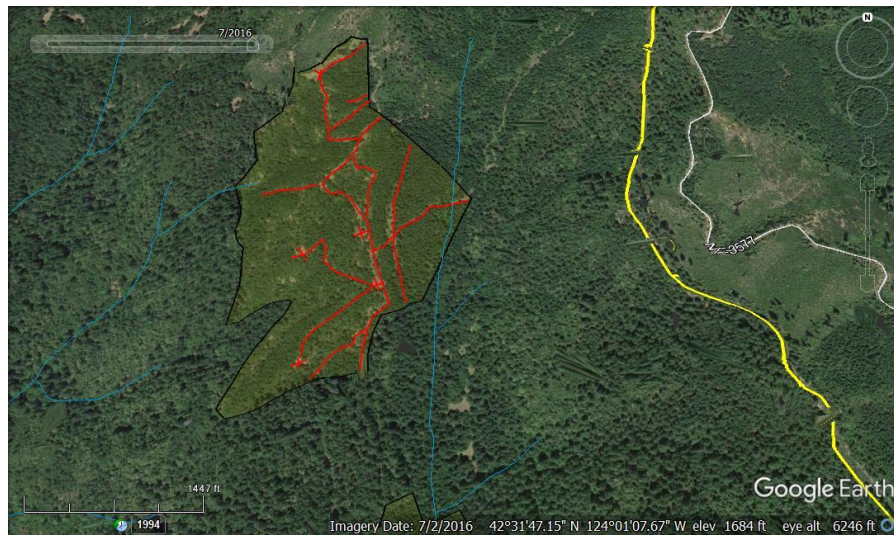


Figure 7. Candidate plantation, Unit 211 2016 Google Earth aerial images.



1. Existing 2018 Klondike Fire Conditions

Methodology

The intent of this summary is to determine if there are fire effects leading to changed conditions for the soils and hydrology resources within the project area of the Shasta Agness project that would change the determinations of the environmental consequences of the project. The data considered for this evaluation referred to the soil burn severity (SBS) data and the BAER assessment to inform the review. The Rapid Assessment of Vegetation Condition After Wildfire (RAVG) was not used to inform the analysis due to the spatial data within the planning area not being available at the time the analysis was written. The most current fire perimeter at the time of analysis was November 3rd, 2018 and therefore will be used for defining the spatial boundary of the fire. It should be noted, the updated SBS from November 27th, 2018 used for the analysis, does not map the SBS for the total burned area within the planning area. There is an approximate 27 acres burned that do not have SBS mapped within the planning area. An estimated 26 acres is within the Lawson Creek fifth field watershed and an estimated one acre is within the Shasta Costa Creek fifth field watershed. Only one acre within the Lawson Creek watershed overlaps with treatment activities proposed for the Shasta Agness project. Review of effects were conducted on the planning and project level scale.

SBS mapping is a rapid assessment tool utilized for Burned Area Emergency Response assessments. SBS maps are a tool used to determine the fire's effect on the ground surface. A fire's soil burn severity is mapped out based on post-fire soil conditions. The intent of the SBS map is to identify fire-induced changes in soil and ground surface properties that may affect infiltration; thus allow for a prediction of accelerated risk of runoff or erosion. The SBS map is intended for the rapid prediction of accelerated runoff and erosion from the post-fire landscape from an expected precipitation event, to highlight potential unacceptable risk to BAER critical values. The soil burn severity numbers were analyzed for the analysis (Table 11). See the SBS map (Figure 8).

Table 11. Soil burn severity acreage for each unit.

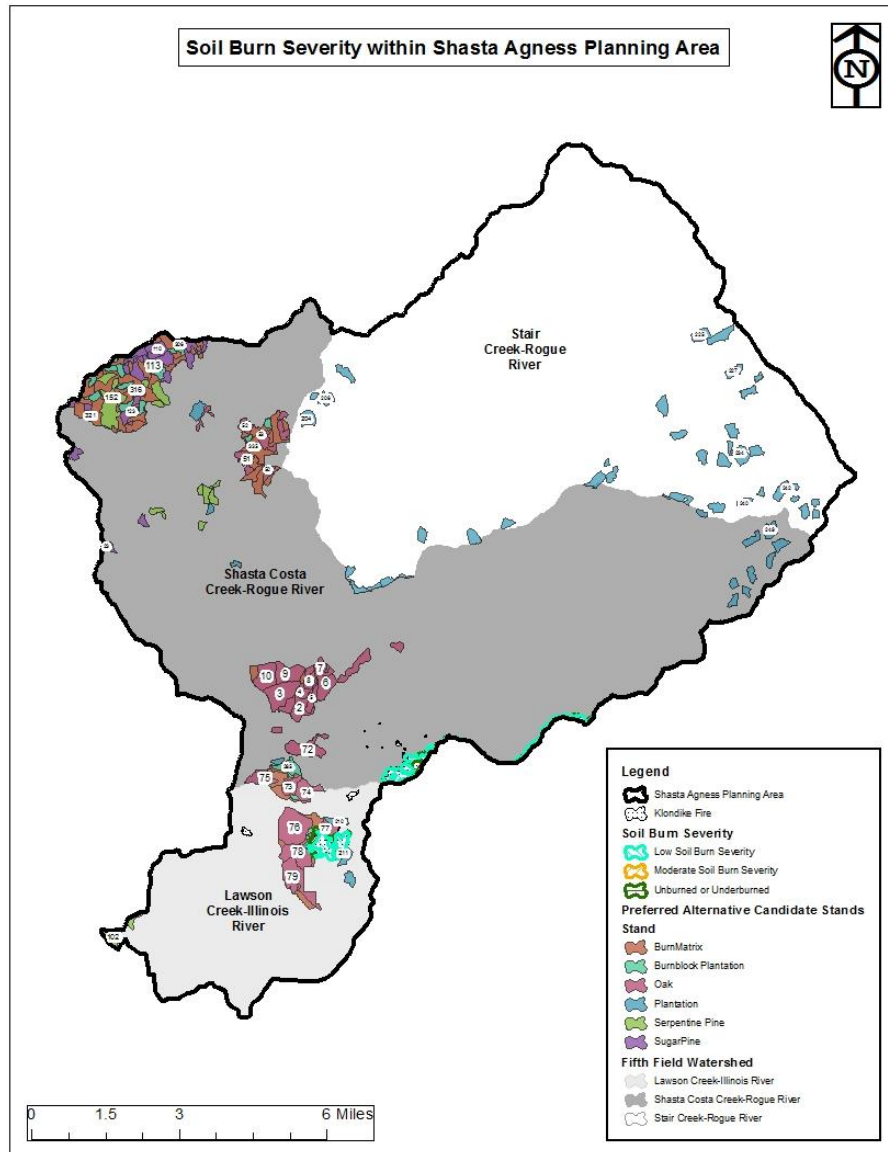
Unit	Watershed	Total Approximate Acres	Acres with High SBS	Acres With Moderate SBS	Acres with Low SBS	Acres with Very low SBS / Unburned	Acres not within Klondike Fire footprint
76 ⁷	Lawson Creek	242	NA	NA	NA	NA	241
77	Lawson Creek	64	0	0	7	4	53
78	Lawson Creek	152	0	0	3	2	147
210	Lawson Creek	41	0	0	<1	<1	40
211	Lawson Creek	67	0	0	26	3	38
288	Lawson Creek	19	0	0	1	6	12

⁷Unit 76 was within the Klondike fire perimeter dated November 3rd, 2018, however the updated soil burn severity map from November 27th, 2018 did not capture this burned area, and therefore there is no data to inform the soil burn severity with which that one acre burned.

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289	Lawson Creek	2	0	0	<1	1	1
370	Lawson Creek	103	0	0	40	18	45
371	Lawson Creek	13	0	0	0	1	12

Figure 8. Soil Burn Severity Map.



Slope Stability

A geologic hazards assessment was conducted during the Taylor and Klondike Fires Burned Area Emergency Response assessment (Cole 2018). This assessment evaluated the potential for increased post-fire risk from debris flows, landslides, rockslides and rockfall to critical values. Field observations and USGS modelling indicated there will be limited post-fire geologic response across the 2018 fire areas. However, the fire impacted areas within the Shasta Agness planning area were not included in the analysis due to extreme weather that expanded the fire perimeter after the BAER assessment was completed. Nonetheless, the geologic hazards assessment is still relevant since the historical information and the geologic setting are similar to those modeled.

The fires impacted a small percentage of the project area and occurred at low soil burn severity, which would reduce or eliminate the likelihood of debris flows during a high precipitation event. Modelling results indicated that 89% of drainages have a probability of less than 0.40 for debris flow occurrence, and 11% of drainages have a probability of 0.60-0.80 for debris flow occurrences (Cole 2018). In addition, according to the assessment, interviews with local staff concluded that post-fire debris flows would most likely occur where roads crossed significant drainages that experienced moderate to high soil burn severity, which was not observed within the project area. As a result, project design criteria and mitigation measures identified in the EIS are still expected to be effective for maintaining slope stability, and there are no changes to the effects analyzed in the soils report.

Soil Productivity

Only a small number of proposed units within the Shasta Agness project experienced some level of wildfire effects from the Klondike Fire. Table 1 displays the breakout of soil burn severity acres for each unit. Soil burn severity was field sampled and mapped by soil scientists during the BAER assessment completed on October 11, 2018, and then updated to include the burned area within the project area on November 27, 2018. Soil burn severity identifies the fire-induced changes in soil and ground surface properties that may affect infiltration, runoff, and erosion potential (Parsons 2002). While effects of fire to overstory canopy is taken into account when evaluating soil burn severity (SBS), SBS ratings do not equate to levels of canopy mortality. Overall the Klondike Fire is considered to be a low severity fire within the project area. Refer to the Silviculture section for more discussion.

None of the proposed units experienced moderate to high SBS fire. The proposed Shasta Agness units experienced low or very low soil burn severity, and acres that were unburned. In these areas, there is no detrimental effects to soils, and there would be no changes to the effects analyzed in the soils report. Furthermore, field reviews are showing a high level of needle cast blanketing the soil surface and replacing the fire-consumed ground cover, which is effectively mitigating any loss of cover within localized areas (J. Brazier, personal communication). Project design criteria and mitigation measures identified in the EIS are still expected to be effective for maintaining soil productivity, and there are no changes to the effects analyzed in the soils report. See Figure 10 and Figure 9 for example images of low SBS within the burned area analyzed under the BAER assessment.

Figure 10. Example of a low SBS area, showing the needle cast and downed wood that is now creating effective ground cover to protect the soils from erosion. Photo Credit: Reinwald and Huynh, 2018.



Figure 9. Example of a low SBS area at a landscape scale. Photo Credit: Reinwald and Huynh, 2018.



Table 11 in the Report identifies the effective groundcover (EGC) minimum protections required for project activities to protect soils from erosion. Based on the low soil burn severity throughout the proposed units, EGC was not adjusted for any of the units. This is because units: 76, 77, 210, 288, 370, and 371 already required 85% EGC; and the remaining units: 78, 211, and 289 identified 70% EGC, which would still be effective to prevent soil erosion with the addition of needle cast aiding in soil surface coverage.

Cumulative Effects

Fire suppression and post-fire rehabilitation work was conducted within the planning area. Fire suppression actions that may have occurred within the planning area include but are not limited to: hand line construction, dozer lines, snag mitigation, road side brushing, hand and aerial ignition, helicopter bucket drops, and aerially delivered retardant. Post-fire rehabilitation that may have occurred include but are not limited to: closure and decommissioning of dozer lines, replacement of damaged culverts, placement of waterbars on trails and roads, and

decommissioning of staging areas. Any road maintenance actions conducted followed the minimum engineering standards. These actions are considered a one-time event and were implemented following project design criteria designed to minimize impact and are repaired post-action. Resource Advisors assigned to the fire ensured that the effects of implemented actions were mitigated or implemented in a way where the effects were negligible on the landscape.

Where these actions directly overlap with proposed units, the project design criteria and mitigation measures for the geologic and soil resource identified in the EIS, which include the Siskiyou National Forest Standards and Guidelines for the maintenance of soil productivity, are still expected to be effective for maintaining slope stability and soil productivity during project implementation.

E. Slope Stability

Landslides are the dominant erosion process in the Shasta Agness planning area, and the majority of these are organically generated. They transpire when the resisting forces on the slope (soil and root cohesion, friction, weight of material) are decreased and driving forces (greater pore pressure, less cohesion, less friction) are increased. The largest slope failures are naturally-occurring slump-earthflows. Slump-earthflows are complex landslides, which tend to be deep seated, and larger features. Slump-earthflows fall as slumps from a headwall and move as flows toward to the toe (Ferrero 1988). However, there are benefits provided by the pulses, which supply large boulders and wood to stream systems for diverse structure. These often have highly productive, deep soils that store, supply moisture, and nutrients to the vegetation and stream systems.

Figure 11 shows the large-scale earthflows and slumps in the planning area, as well as the ultramafic bands of peridotite/serpentine rock and soils, and how these features relate to estimated fault lines. These flows and landslides are associated with the Galice and Lookingglass Formations (mudstones, siltstones, fine-grained sandstones), or ultramafic rocks within the project area. The oversteepening of inner gorge slides due to rapid stream cutting at the toeslopes and the oversteepening of slopes where they are overlain by thick deposits of sandstones are the major causes of localized bank failures and slumping, and trees tipping into and across the channel in SA. The Lookingglass Formation is also particularly sensitive to large earthflow-slump failures, which is located in the west portion of the planning area. Particular attention within this terrain needs to be focused in the vicinity of Billings and Foster Creek since large quantities of fine-grained sediment have constricted or deflected these streams in the past. In addition ultramafic peridotite/serpentine parent rocks and soils support unique and endemic plant communities that may warrant different approaches to management of those landscapes.

Landflow and landslump terrain represents terrain that is active now or has been active during the past history of the slope. Soils can vary from shallow to very deep, and some may have sag ponds and wet spots in slump basin areas. The high quantity of this terrain is a direct result of the numerous faults and fractures that cut through geologic formations and have created zones of sheared rock and contact points between different formations. These create areas of instability through differences in erosion rates between rock units, concentrations of sheared or less resistant rock such as serpentine, deeper soil development, and concentrations of ground or surface water following topographic lows. The large earthflow in the Foster Creek watershed is an example of how a combination of these factors can produce unstable terrain.

Many of these earthflows are constantly moving downslope, but can be accelerated by intense or prolonged rainfall. They typically contribute silt to clay sized sediment, which is usually

transported instead of deposited, creating turbid pulses of streamflow. Failures can also occur during the dry season, since soils in these landflows can hold lots of moisture.

GIS modelling of the planning area was conducted to help identify the range of risk for potential slope instability and soil erosion risk. This modeling analyzes slope gradient, slope aspect, slope curvature, and upslope contributing area based on the Digital Elevation Model in ArcMap (explained in more detail under the “Information sources and Field Techniques” section of this report), to estimate the potential for instability across the planning area landscape. Figure 12 displays the estimated risk, broken out by low, moderate, high, or very high risk for instability.

Figure 11. Landflows, landslides, and serpentine geology and soils in the Shasta Agness Planning Area associated with high amounts of faulting.

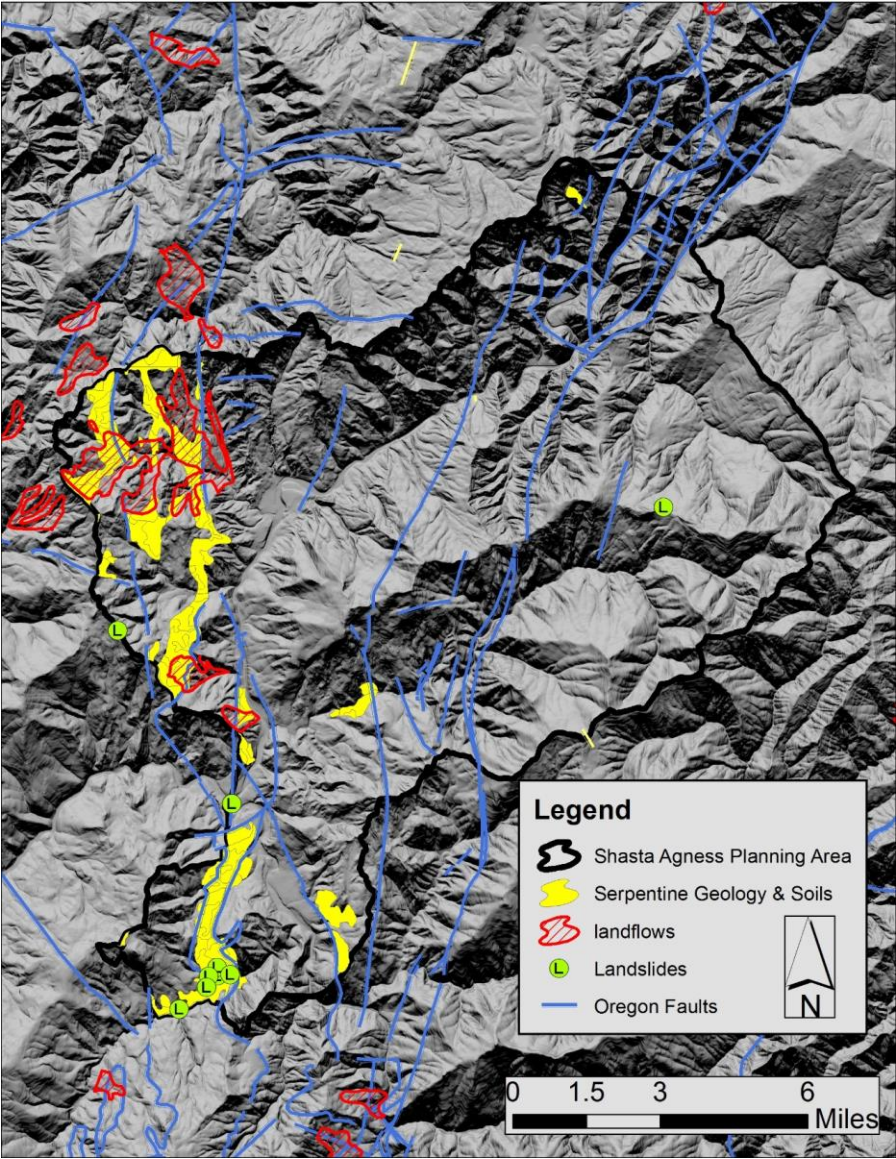
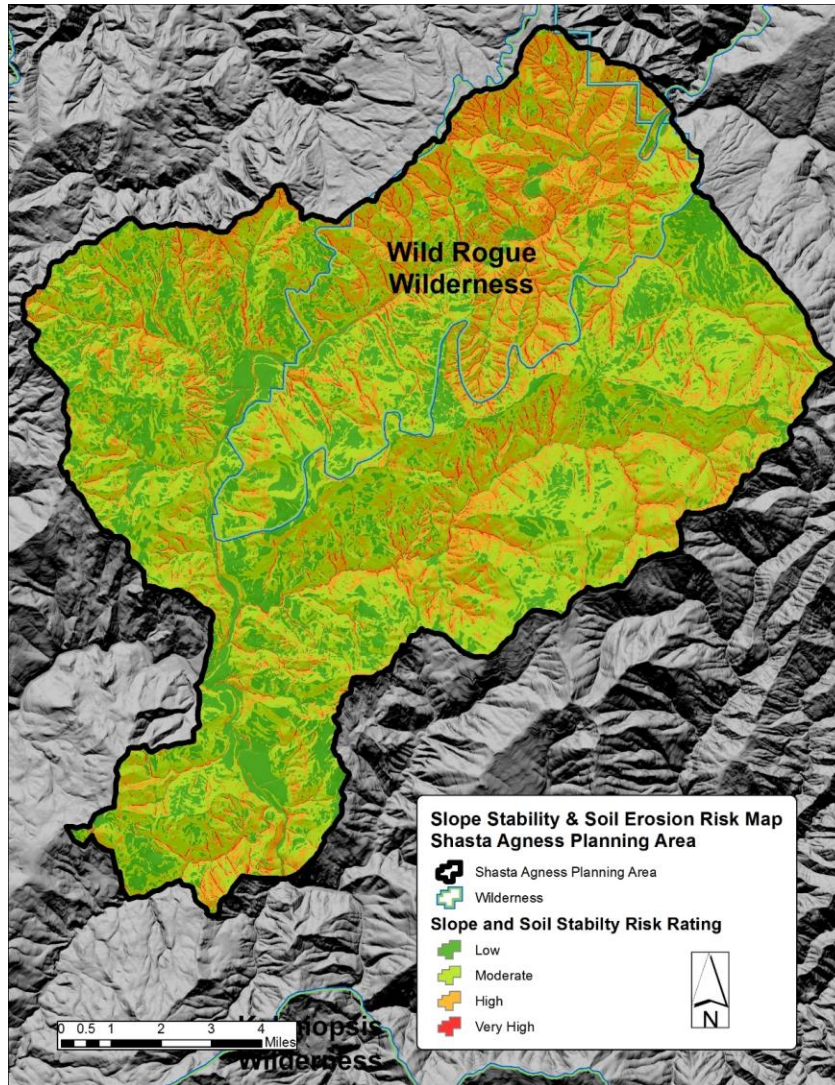


Figure 12. Slope stability and soil erosion risk within the Shasta Agness planning area.



VI. Effects Mechanism and Analysis Framework

A. Silvicultural Treatments

The proposed silvicultural treatments have the potential to affect soil productivity, organic matter, and large woody material through changes to vegetation. Detrimental disturbance as it relates to implementing these silvicultural treatments will be discussed under ‘Harvest Logging Systems’, below.

Vegetation uptakes nutrients from the soil in a mostly soluble, inorganic form and converts them into an organic form for metabolism. Most of a tree’s nutrients are distributed in the leaves, twigs, and branches. As the tree discards leaves, branches, and bark, or dies, the plant’s nutrients are returned to the soil. Organic material returned to the soil is decomposed and the nutrients are mineralized (i.e., converted to an inorganic form) by soil organisms depending on the soil’s physical conditions (moisture, temperature, aeration, etc.) (Farve and Napper 2009). All silvicultural treatments manipulate to various extents the vegetative component of a soil’s nutrient cycle.

In the forest, precipitation is intercepted, retained, and redistributed by the tree canopy. Water ultimately evaporates from the canopy (interception) or drips through (through-fall) or runs down the stems (stem flow) to the forest floor. Tree canopies intercept precipitation, moderating and metering its fall to the soil surface. They also redirect this intercepted moisture toward the drip line of the tree, and away from the base of the trunk.

In extreme rainfall conditions in the absence of deep-crowned tree cover, such as following clear cut or shelterwood logging, the rate of water striking the surface could exceed the rate of the soil’s ability to absorb it, with localized sheet erosion a likely result. Such effects are generally only relevant to degrees of canopy removal associated with clear cutting or shelterwood logging, or high intensity stand replacement fire.

Dawson (1998) suggested that fog may provide benefits beyond additional water which could influence the ecology of forest plants and the biogeochemistry of the forested ecosystem they compose; for example, on plant photosynthesis, temperature gradients, and nutrient cycling. Dawson anticipated a decline in fog inputs due to tree removal which could cause more xeric site conditions and influence the biogeochemistry of the forest because as moisture inputs decline so do nutrient inputs, decomposition, and mineral cycling in forest soils. These results were primarily focused within redwood stands in CA, and were predicted in association with canopy loss.

In another study, Carbone et. al. (2011) studied seasonal and episodic moisture controls on plant and microbial contributions to soil respiration. This study was conducted in a pine forest ecosystem with a Mediterranean-type climate receiving seasonally varying precipitation inputs from both rainfall (in the winter) and fog-drip (primarily in the summer). They found seasonal changes in soil respiration (SR) were driven by surface soil water content and large changes in root respiration contributions. Furthermore, they concluded that root and microbial respiration sources respond differently in timing and magnitude to both seasonal and episodic moisture inputs. They also indicated that in Mediterranean-type climates, where winters are wet but cool, small water inputs during the warm summers have the potential to stimulate biological activity and to be important in the overall annual carbon cycle. This study uniquely showed that the

timing and magnitude with which plant and microbial respiration sources respond to episodic pulses of moisture differ (Carbon et. al. 20011).

As discussed in chapter 3, prescribed amounts of snags and downed wood would be left on a per acre basis consistent with plant association group capabilities where existing amounts are below such levels. However, this mitigation is only effective where such snags are available in adequate numbers. Where they are not available, they would be created from remaining live trees. Snag creation would have a positive effect on long-term soil productivity since snags are a source of future down logs, which are a critical component of long-term soil productivity. However, there is a limit to this mitigation. Snag creation invariably creates “hard” snags, not those in advanced stages of decay.

Ideally, a stand would have representatives of snags in all stages of decay at any one time. Since silvicultural treatments and logging exert a disproportional impact on soft snags (since they are most likely to be felled as hazards) than hard snags, and they can only be replaced with created or retained hard snags, the inevitable result is an imbalance between the number of snags in advanced decay (near-term down logs) and hard snags (likely to remain hard as either a snag or down log) for a few decades.

1. **Soil Available Water Storage and Resilience to Drought**

Table 12 identifies the dominant soil water holding capacities for each proposed unit in Shasta Agness project area for Alternative 1. Alternative 2 and 3 propose less units for unique habitat restoration, however unit numbers don’t change from Alternative 1 with the changes in objective for the different alternatives. For that reason, Table 12 will also be referenced to describe dominant soil water holding capacities for Alternative 2 and 3. Appendices 1 and 2, describing the soil characteristics found within the planning area, also indicate the available water capacity (AWC) for each soil map unit. During implementation minimum effective ground coverage (EGC) needed to protect the soils from erosion has been identified in Table 12, based on forest plan standards and guidelines and soil map units. EGC will use duff, litter, and harvest residue (branches, needles/leaves, logs, etc.) to provide soil cover. This organic matter is also important for aiding in the capture and retention of soil moisture. Slopes dominated by low and very low water holding capacities that are currently supporting closed canopy forests that were able to get established during wet climatic cycles and have lacked regular disturbance due to wildfire suppression are not resilient over time due to competition for limited soil water that becomes acute during drought periods. By contrast, High areas are the most resilient. Refer to the Silviculture Report for more information regarding stand productivity in regards to drought vulnerability and stand health. Stands in the Shasta Agness planning area exhibit lower capacity for AWS, and are therefore primary targets for oak and pine restoration, since these species are more drought-resistant and tend to be found in greater abundance in these soil conditions. Components of the action alternatives would not negatively impact the water holding capacity of these stands. PDCs and BMPs would protect soil cover, and lower the density of Douglas fir, which would reduce overall competition for scarce available water.

Table 12. Soil characteristics and corresponding protective measures of candidate stands within the Shasta Agness planning area.

Unit No.	Primary Objective ⁸ – Alt. 1	Soil Map Units	Dominant Soil Water Holding Capacity	Erosion Potential	Minimum required EGC (most restrictive)
1	Oak	158F 267F 61A 197E 1D	Moderate	158F-Severe 267F-Severe 61A- Slight 197E- Moderate 1D-Slight	70%
2	Oak	267F 112A 158F 61A 197E 13G 257A 217	Low; Moderate	267F- Severe 112A-Slight 158F-Severe 61A- Slight 197E- Moderate 13G-Very Severe 257A-Slight 217- Rock Outcrop	85%
3	Oak	233F 267F 22F 197E 61A 1B 25G 1D	Moderate	233F- Severe 267F-Severe 22F- Severe 197E- Moderate 61A-Slight 1B- Slight 25G- Very Severe 1D- Slight	85%
4	Oak	267F 197E 25G	Very Low; Low	267F- Severe 197E- Moderate 25G- Very Severe	85%
5	Oak	267F 197E 257A	Low; Moderate	267F- Severe 197E- Moderate 257A- Slight	70%
6	Oak	267F 233F 158F 197E	Low; Moderate	267F- Severe 233F- Severe 158F- Severe 197E- Moderate	70%
7	Oak	25G 267F 233F 159F 197E	Very Low; Low	25G-Very Severe 267F-Severe 233F- Severe 159F- Severe 197E- Moderate	85%
8	Oak	267F 159F 197E 25G	Very Low; Low; Moderate	267F- Severe 159F- Severe 197E- Moderate	85%

⁸ Riparian Reserves occur throughout all units. Where aquatic management zones occur riparian reserve stand health is also a primary objective.

				25G- Very Severe	
9	Oak	233F 197E 25G	Moderate	233F- Severe 197E- Moderate 25G- Very Severe	85%
10	Oak	233F 22F 197E 61A	Moderate	233F- Severe 22F- Severe 197E- Moderate 61A- Slight	70%
11	Oak	233F 159F 25G 197E	Very Low; Low; Moderate	233F- Severe 159F- Severe 25G- Very Severe 197E- Moderate	85%
12	Oak	233F 267F 159F 25G	Very Low; Low	233F- Severe 267F- Severe 159F- Severe 25G- Very Severe	85%
23	Sugar pine	73F 242G 54F 31F 264F 53F	Very Low; Low	73F- Severe 242G- Very Severe 54F- Severe 31F- Severe 264F- Severe 53F- Severe	85%
29	Sugar pine	56F 241E 33E 28F	Low	56F- Severe 241E- Moderate 33E- Moderate 28F- Severe	70%
33	Sugar pine	28F 211G 212G 53F 31F	Very Low; Low	28F- Severe 211G- Very Severe 212G- Very Severe 53F- Severe 31F- Severe	85%
39	Sugar pine	211G 210G	Very Low	211G- Very Severe 210G- Very Severe	85%
50	Oak	9F 8E 221D 1D	Low; High	9F- Severe 8E- Moderate 221D- Moderate 1D- Slight	70%
51	Oak	9F 8E	Low	9F- Severe 8E- Moderate	70%
52	Oak	9F 9G	Low	9F- Severe 9G- Very Severe	85%
53	Oak	9F 22F 197E 8E	Low; Moderate	9F- Severe 22F- Severe 197E- Moderate	70%

				8E- Moderate	
54	Oak	22F 9G 9F 23G	Low	22F- Severe 9G- Very Severe 9F- Severe 23G- Very Severe	85%
55	Oak	9G 9F	Low	9G- Very Severe 9F- Severe	85%
57	Oak	9F 132F	Low	9F- Severe 132F- Severe	70%
58	Oak	9F 104E 132F	Low	9F- Severe 104E- Moderate 132F- Severe	70%
59	Sugar pine	91F 88F 90E	Very Low; Low	91F- Severe 88F- Severe 90E- Moderate	70%
60	Sugar pine	91F 90E	Very Low; Low	91F- Severe 90E- Moderate	70%
61	Sugar pine	279E 91G 91F 232F	Low; Moderate	279E- Moderate 91G- Very Severe 91F- Severe 232F- Severe	85%
62	Sugar pine	232F 91F 200F 88F 85F	Low; Moderate	232F- Severe 91F- Severe 200F- Severe 88F- Severe 85F- Severe	70%
70	Oak	233F 25G 158F	Moderate	233F- Severe 25G- Very Severe 158F- Severe	85%
71	Oak	158F 267F	Low	158F- Severe 267F- Severe	70%
72	Oak	267F 158F 233F	Low	267F- Severe 158F- Severe 233F- Severe	70%
73	Oak	25G 197E 267F	Moderate	25G- Very Severe 197E- Moderate 267F- Severe	85%
74	Oak	197E 267F 233F	Low; Moderate	197E- Moderate 267F- Severe 233F- Severe	70%
75	Oak	197E 13G 233F 221B 25G 119A	Moderate	197E- Moderate 13G- Very Severe 233F- Severe 221B- Slight 25G- Very Severe 119A- Slight	85%

76	Oak	197E 233F 158F 267F 25G	Moderate	197E- Moderate 233F- Severe 158F- Severe 267F- Severe 25G- Very Severe	85%
77	Oak	25G 233F 13G	Very Low; Moderate	25G- Very Severe 233F- Severe 13G- Very Severe	85%
78	Oak	197E 94F 158F 119A 233F 112A 221D 221B	Moderate	197E- Moderate 94F- Severe 158F- Severe 119A- Slight 233F- Severe 112A- Slight 221D- Moderate 221B-Slight	70%
79	Oak	196C 94F 1B 119A 233F 196D 221D 221B	Moderate; High	196C- Slight 94F- Severe 1B-Slight 119A- Slight 233F- Severe 196D- Moderate 221D- Moderate 221B- Slight	70%
80	Oak	1B 233F 221B	Moderate; High	1B-Slight 233F- Severe 221B- Slight	70%
101	Serpentine Pine	90E 182F 91F	Very Low; Low	90E- Moderate 182F- Severe 91F- Severe	70%
102	Serpentine Pine	73F 182F 91F 17E 80F 74F	Very Low	73F- Severe 182F- Severe 91F- Severe 17E- Moderate 80F- Severe 74F- Severe	70%
110	Sugar Pine	234F 232F	Low; Moderate	234F- Severe 232F- Severe	70%
111	Sugar Pine	234F 232F	Low; Moderate	See Unit 110	70%
112	Sugar Pine	234F 88F 232F 147E	Low; Moderate	234F- Severe 88F- Severe 232F- Severe 147E- Moderate	70%
113	Sugar Pine	230E 232F 147E 234F	Low; Moderate	230E- Moderate 232F- Severe 147E- Moderate 234F- Severe	70%

114	Sugar Pine	91G 91F 232F	Low	91G- Very Severe 91F- Severe 232F- Severe	85%
115	Sugar Pine	91G 91F	Very Low	91G- Very Severe 91F- Severe	85%
116	Sugar Pine	91G 91F 232F	Very Low	91G- Very Severe 91F- Severe 232F- Severe	85%
117	Serpentine Pine	91F 232F	Very Low; Low	91F- Severe 232F- Severe	70%
118	Sugar Pine	91F	Very Low	91F- Severe	70%
119	Sugar Pine	88F 232F 234F	Moderate	88F- Severe 232F- Severe 234F- Severe	70%
120	Serpentine Pine	230E 104E 232F 234F 133G 132F	Low	230E- Moderate 104E- Moderate 232F- Severe 234F- Severe 133G- Very Severe 132F- Severe	85%
121	Serpentine Pine	91F 133G 132F	Very Low; Low	91F- Severe 133G- Very Severe 132F- Severe	85%
122	Sugar Pine	91G 90E 91F	Very Low	91G- Very Severe 90E- Moderate 91F- Severe	85%
123	Sugar Pine	91G 232F 240E 91F 90E	Very Low; Low	91G- Very Severe 232F- Severe 240E- Moderate 91F- Severe 90E- Moderate	85%
124	Sugar Pine	91F 90E	Low	91F- Severe 90E- Moderate	70%
125	Sugar Pine	232F 230E	Low	232F- Severe 230E- Moderate	70%
150	Serpentine Pine	176F 91F 54F 53F	Low	176F- Severe 91F- Severe 54F- Severe 53F- Severe	70%
151	Serpentine Pine	240E 176F 53F 90E	Low	240E- Moderate 176F- Severe 53F- Severe 90E- Moderate	70%
152	Serpentine Pine	232F 240E	Very Low; Low	232F- Severe	85%

		231F 176F 90E 242G 91F 53F 54F		240E- Moderate 231F- Severe 176F- Severe 90E- Moderate 242G- Very Severe 91F- Severe 53F- Severe 54F- Severe	
153	Serpentine Pine	88F 230E	Low	88F- Severe 230E- Moderate	70%
154	Serpentine Pine	105F	Low	105F- Severe	70%
155	Serpentine Pine	9F 105F 132F	Low	9F- Severe 105F- Severe 132F- Severe	70%
157	Serpentine Pine	9F 8E	Low	9F- Severe 8E- Moderate	70%
158	Serpentine Pine	9F 104E 132F	Low	9F- Severe 104E- Moderate 132F- Severe	70%
159	Serpentine Pine	88F 132F 90E	Low	88F- Severe 132F- Severe 90E- Moderate	70%
201	DELSH ⁹	88F 104E 132F	Low	See Unit 159	70%
202	DELSH	9F	Low	9F- Severe	70%
203	DELSH	8E 9F 104E 132F	Low	8E- Moderate 9F- Severe 104E- Moderate 132F- Severe	70%
204	DELSH	22F 8E 197E 85F	Low; SE corner Moderate	22F- Severe 8E- Moderate 197E- Moderate 85F- Severe	70%
205	DELSH	85F 198E	High; Moderate	85F- Severe 198E- Moderate	70%
206	DELSH	85F	Moderate	85F- Severe	70%
207	DELSH	198E 85F 201F	Moderate; High	198E- Moderate 85F- Severe 201F- Severe	70%
209	DELSH	13G	Low	13G- Very Severe	85%
210	DELSH	158F 233F 13G	Low	158F- Severe 233F- Severe 13G- Very Severe	85%
210	DELSH	233F	Low	233F- Severe	85%

⁹ DELSH= Develop and enhance late seral habitat

		99E 25G		99E- Moderate 25G- Very Severe	
211	DELSH	233F	Very Low; Moderate	233F- Severe	70%
212	DELSH	35G 21F 99E 158F 20E	Moderate	35G- Very Severe 21F- Severe 99E- Moderate 158F- Severe 20E- Moderate	85%
213	DELSH	21F 5F 20E	Low	21F- Severe 5F- Severe 20E- Moderate	70%
214	DELSH	21F 5F	Low	21F- Severe 5F- Severe	70%
215	DELSH	21F 5F 124E 265F	Low	21F- Severe 5F- Severe 124E- Moderate 265F- Severe	70%
216	DELSH	265G 124E	Low	265G- Very Severe 124E- Moderate	85%
217	DELSH	21F 20E 35G 124E	Low	21F- Severe 20E- Moderate 35G- Very Severe 124E- Moderate	85%
218	DELSH	159F 9G	Low	159F- Severe 9G- Very Severe	85%
219	DELSH	21F 20E	Low	21F- Severe 20E- Moderate	70%
220	DELSH	175G 250F	Low	175G- Very Severe 250F- Severe	85%
221	DELSH	124E 35G 239G 265G 265F	Low	124E- Moderate 35G- Very Severe 239G- Very Severe 265G- Very Severe 265F- Severe	85%
222	DELSH	20E 250F	Low	20E- Moderate 250F- Severe	70%
223	DELSH	20E 155F 250F 265F	Low	20E- Moderate 155F- Severe 250F- Severe 265F- Severe	70%

224	DELSH	110E	Low	110E- Moderate	60%
225	DELSH	110E	High	See Unit 224	60%
226	DELSH	110E 109F 110D	High	110E- Moderate 109F- Very Severe 110D- Moderate	85%
227	DELSH	110E 109F	High	Same as Unit 226	85%
228	DELSH	110E 109F	High	Same as Unit 226	85%
229	DELSH	175G 110E	High	175G- Very Severe 110E- Moderate	85%
230	DELSH	108F 176G 91G 110E	High	108F- Very Severe 176G- Very Severe 91G- Very Severe 110E- Moderate	85%
231	DELSH	108F	Moderate; High	108F-Very Severe	85%
232	DELSH	110E 108F 174F	Moderate	110E- Moderate 108F-Very Severe 174F-Severe	85%
233	DELSH	110E 251F 108F 174F	Low; High	110E- Moderate 251F- Severe 108F- Very Severe 174F- Severe	85%
234	DELSH	110E 251F 174F	Low; High	110E- Moderate 251F-Severe 174F- Severe	70%
235	DELSH	20E 265F 244G 250F	Low; High	20E-Moderate 265F- Severe 244G- Very Severe 250F- Severe	85%
236(STAIRCCK7)	DELSH	174F 91G	Very Low; Low	174F- Severe 91G- Very Severe	85%
236(BEARCAMP12)	DELSH	20E 174F 250F 155F 250F	Low	20E- Moderate 174F- Severe 250F- Severe 155F- Severe 250F- Severe	70%
237	DELSH	124E 265F	Low	124E- Moderate 265F- Severe	70%
237	DELSH	244G 250F	Low	244G- Very Severe	85%

				250F- Severe	
238	DELSH	245G 265G 124E	Low	245G- Very Severe 265G- Very Severe 124E- Moderate	85%
239	DELSH	265G	Low	265G- Very Severe	85%
240	DELSH	245G 265G	Low	245G- Very Severe 265G- Very Severe	85%
241	DELSH	245G	Low	245G- Very Severe	85%
242	DELSH	245G 140F	Low	245G- Very Severe 140F- Severe	85%
243	DELSH	245G 140F	Low	Same as Unit 242	85%
244	DELSH	245G 140F	Very Low; Low	Same as Unit 242	85%
245	DELSH	156G 5F 35G 21F	Low	156G- Very Severe 5F- Severe 35G- Very Severe 21F- Severe	85%
246	DELSH	156G 5F	Low	156G- Very Severe 5F- Severe	85%
248	DELSH	156G 35G 140F 21F	Low	156G- Very Severe 35G- Very Severe 140F- Severe 21F- Severe	85%
249	DELSH	140F 21F 265F	Low	140F- Severe 21F- Severe 265F- Severe	70%
250	DELSH	156G 21F	Low	156G- Very Severe 21F- Severe	85%
251	DELSH	265G 156G 140F	Very Low	265G- Very Severe 156G- Very Severe 140F- Severe	85%
252	DELSH	140F	Low	140F- Severe	70%
253	DELSH	265F 21F 140F	Low	265F- Severe 21F- Severe 140F- Severe	70%
254	DELSH	140F	Very Low	140F- Severe	70%
255	DELSH	265F 21F 140F	Very Low; Low	Same as Unit 253	70%
270	Burnblock Plantation	91F 88F 232F 90E	Low; Moderate	91F- Severe 88F- Severe 232F- Severe	70%

				90E- Moderate	
271	Burnblock Plantation	88F 232F	Low; Moderate	88F- Severe 232F- Severe	70%
272	Burnblock Plantation	230E 232F 147E 234F	Low; Moderate	230E- Moderate 232F- Severe 147E- Moderate 234F- Severe	70%
273	Burnblock Plantation	91F 54F	Low	91F- Severe 54F- Severe	70%
274	Burnblock Plantation	176F 91F 54F	Very Low	176F- Severe 91F- Severe 54F- Severe	70%
275	Burnblock Plantation	91F 54F	Low	91F- Severe 54F- Severe	70%
276	Burnblock Plantation	54F 212G 240E	Low	54F- Severe 212G- Very Severe 240E- Moderate	85%
277	Burnblock Plantation	91G 176F 90E	Low	91G- Very Severe 176F- Severe 90E- Moderate	85%
278	Burnblock Plantation	28F 211G 212G 210G	Very Low; Low	28F- Severe 210G- Very Severe 211G- Very Severe 212G- Very Severe	85%
279	Burnblock Plantation	28F 212G	Low	28F- Severe 212G- Very Severe	85%
280	Burnblock Plantation	240E 212G 53F	Low	240E- Moderate 212G- Very Severe 53F- Severe	85%
281	Burnblock Plantation	91F 91G 90E	Very Low	91F- Severe 91G- Very Severe 90E- Moderate	85%
282	Burnblock Plantation	91G 91F	Very Low	91G- Very Severe 91F- Severe	85%
283	Burnblock Plantation	8E 9F 9G	Low	8E- Moderate 9F- Severe 9G- Very Severe	85%
284	Burnblock Plantation	9F	Low	9F- Severe	70%
285	Burnblock Plantation	13G 233F 158F 25G 197E	Low	13G- Very Severe 233F- Severe 158F- Severe	85%

				25G- Very Severe 197E- Moderate	
286	Burnblock Plantation	13G 25G 197E	Very Low	13G- Very Severe 25G- Very Severe 197E- Moderate	85%
287	Burnblock Plantation	197E 267F	Low	197E- Moderate 267F- Severe	70%
288	Burnblock Plantation	197E 25G 233F	Very Low; Moderate	197E- Moderate 25G- Very Severe 233F- Severe	85%
289	Burnblock Plantation	197E 158F 233F	Moderate	197E- Moderate 158F- Severe 233F- Severe	70%
302	Burn between	91F 200F 85F 90E	Very Low	91F- Severe 200F- Severe 85F- Severe 90E- Moderate	70%
303	Burn between	91F 88F	Very Low	91F- Severe 88F- Severe	70%
304	Burn between	232F 88F	Low	232F- Severe 88F- Severe	70%
305	Burn between	91F 88F	Very Low	Same as Unit 304	70%
306	Burn between	91F 248F 90E 232F	Very Low; Low- East Half; Moderate- West Half	91F- Severe 248F- Severe 90E- Moderate 232F- Severe	70%
307	Burn between	88F 232F	Low	88F- Severe 232F- Severe	70%
308	Burn between	91F 88F 90E	Low	91F- Severe 88F- Severe 90E- Moderate	70%
309	Burn between	88F 147E 234F	Low; Moderate	88F- Severe 147E- Moderate 234F- Severe	70%
310	Burn between	53D	Moderate	53D- Moderate	60%
311	Burn between	230E 91G 91F 232F	Very Low; Low	230E- Moderate 91G- Very Severe 91F- Severe 232F- Severe	85%
312	Burn between	230E 232F 234F	Low	230E- Moderate 232F- Severe 234F- Severe	70%

313	Burn between	279E 91F 54F 232F	Very Low; Low	279E- Moderate 91F- Severe 54F- Severe 232F- Severe	70%
314	Burn between	54F	Low	54F- Severe	70%
315	Burn between	240E 176F 91F 53F 54F 212G	Low	240E- Moderate 176F- Severe 91F- Severe 53F- Severe 54F- Severe 212G- Very Severe	85%
316	Burn between	91G 240E 176F 90E 91F 54F	Very Low	91G- Very Severe 240E- Moderate 176F- Severe 90E- Moderate 91F- Severe 54F- Severe	85%
317	Burn between	91G 176F 90E	Low	91G- Very Severe 176F- Severe 90E- Moderate	85%
318	Burn between	91F 232F 133G 132F	Very Low; Low	91F- Severe 232F- Severe 133G- Very Severe 132F- Severe	85%
319	Burn between	91G 91F	Very Low	91G- Very Severe 91F- Severe	85%
320	Burn between	28F 211G 54F 212G 240E 53F 31F	Low	28F- Severe 211G- Very Severe 54F- Severe 212G- Very Severe 240E- Moderate 53F- Severe 31F- Severe	85%
321	Burn between	232F 240E 28F 231F 211G 242G 249F 212G 53F 31F	Very Low; Low	232F- Severe 240E- Moderate 28F- Severe 231F- Severe 211G- Very Severe 242G- Very Severe 249F- Severe 212G- Very Severe 53F- Severe 31F- Severe	85%

322	Burn between	232F 240E 242G 91F	Low	232F- Severe 240E- Moderate 242G- Very Severe 91F- Severe	85%
324	Burn between	232F 91F 91G 90E	Very Low; Low	232F- Severe 91F- Severe 91G- Very Severe 90E- Very Severe	85%
325	Burn between	232F 91F 91G 90E	Very Low; Low	Same as Unit 324	85%
330	Burn between	22F 9G 9F	Low	22F- Severe 9G- Very Severe 9F- Severe	85%
331	Burn between	22F 197E 9G 9F 23G	Low	22F- Severe 23G- Very Severe 197E- Moderate 9G- Very Severe 9F- Severe	85%
332	Burn between	22F 197E	Low; Moderate	22F- Severe 197E- Moderate	70%
333	Burn between	22F 197E 8E 9F 9G	Low	22F- Severe 197E- Moderate 8E- Moderate 9F- Severe 9G- Very Severe	85%
334	Burn between	9F	Low	9F- Severe	70%
335	Burn between	9F 22F 197E 8E	Low	9F- Severe 22F- Severe 197E- Moderate 8E- Moderate	70%
336	Burn between	9F	Low	9F- Severe	70%
337	Burn between	9F 8E	Low	9F- Severe 8E- Moderate	70%
338	Burn between	9F 8E 257A 61A 1D 1B	Low	9F- Severe 8E- Moderate 257A- Slight 61A- Slight 1D- Slight 1B- Slight	70%
339	Burn between	221D 61A	Moderate; High	221D- Moderate 61A- Slight	60%
350	Burn between	25G 267F	Very Low; Low	25G- Very Severe	85%

		159F		267F- Severe	
351	Burn between	159F 197E	Low	159F- Severe 197E- Moderate	70%
352	Burn between	267F 159F 197E	Low; Moderate	267F- Severe 159F-Severe 197E- Moderate	70%
353	Burn between	197E 25G	Very Low	197E- Moderate 25G- Very Severe	85%
354	Burn between	233F 197E 61A	Moderate	233F- Severe 197E- Moderate 61A- Slight	70%
360	Burn between	13G 233F 25G	Very Low	13G- Very Severe 233F- Severe 25G- Very Severe	85%
361	Burn between	197E 13G 233F 25G	Very Low; Moderate	197E- Moderate 13G- Very Severe 233F- Severe 25G- Very Severe	85%
362	Burn between	25G 197E	Very Low	25G- Very Severe 197E- Moderate	85%
363	Burn between	13G 197E 233F 25G 267F	Very Low; Low	13G- Very Severe 197E- Moderate 233F- Severe 25G- Very Severe 267F- Severe	85%
364	Burn between	13G 197E 158F 267F	Low	13G- Very Severe 197E- Moderate 158F- Severe 267F- Severe	85%
370	Burn between	197E 158F 267F 25G 13G 233F	Northern unit- Moderate Southern unit- Very Low	197E- Moderate 158F- Severe 267F- Severe 25G- Very Severe 13G- Very Severe 233F- Severe	85%
371	Burn between	197E 25G 233F	Moderate	197E- Moderate 25G- Very Severe 233F- Severe	85%

372	Burn between	197E 233F	Moderate	197E- Moderate 233F- Severe	70%
373	Burn between	197E 94F 25G 233F	Moderate	197E- Moderate 94F- Severe 25G- Very Severe 233F- Severe	85%
375	Burn between	112A 196C 196D	High	112A- Slight 196C- Slight 196D- Moderate	60%

B. Harvest Logging Systems

1. Ground Based Systems (tractor, rubber-tired skidder, harvester-forwarder)

Ground-based logging systems have the greatest potential to adversely affect short and long-term soil productivity. Logging and other equipment can compact and ‘puddle’ soils over which they operate (landings, skid roads, roadways, etc.). Tractor, or ground based logging has the greatest potential to cause soil compaction, which decreases soil volume and pore space and modifies soil structure and results in a decrease in gas, water, and nutrient exchange, slows root penetration, and can aggravate soil drought, especially in Mediterranean climates such as that of SW Oregon (Atzet et al., 1989), though soil drought may be less of a concern here where there is a much stronger maritime weather influence. Puddling is the destruction of soil structure, primarily when wet, by severe compaction, to the point where ruts or imprints are made and the soil structure has been so destroyed as to prevent water from infiltrating into the soil profile.

Compaction may inhibit occupation of the soil by organisms that assist in the decomposition of wood to soil organic material that improves site productivity, and help to aerate the soil. Compaction also possibly inhibits the growth of beneficial fungi (mycorrhizae) that provide nutrients to plant roots (Kestlick, 1997). Ectomycorrhizal fungi form an essential interface between soil and trees. They usually colonize more than 90 percent of the feeder roots of host plants (Goodman and Trofymow, 1998). Plant development is also restricted in compacted soils due to poor aeration and impeded root growth. As a result, soil productivity is adversely affected (Floch, 1988).

Soil moisture content, soil characteristics, and force affect the level of compaction that can occur from harvest systems. Fine-textured soils dominated by expandable clay minerals, and well-graded, coarser textured soils are most likely to compact when moist, whereas finer textured soils dominated by non-expandable clay minerals, and of poorly graded, coarser textured soils such as most pumice and coarse ash soils, are less affected by soil moisture (Atzet et al, 1989).

Compaction from logging activities is now routinely mitigated, by designating and minimizing the number of skid trails used; by requiring logging equipment to use only those roads and skid trails created during past timber harvest where feasible; using equipment and or techniques shown effective to prevent or minimize compaction (such as low psi (pounds per square inch) or operating on slash to disperse weight); and allowing operations only during conditions when soils are unlikely to be detrimentally compacted beyond the 15% LRMP allowances (such as on dry or frozen ground; or over deep snow with a firm base). These mitigations have been proven successful and are applied to all Action Alternatives in this project (DEIS, Appendix B).

Detrimental displacement is defined as the removal of more than 50% of the soil's 'A' horizon (topsoil) from an area greater than 100 square feet that is at least 5 feet in width. This displacement occurs by natural means, such as heavy rains that cause erosion on exposed surfaces (such as skid trails and skyline corridors), or by mechanical means such as churning tractor treads or dragging of logs across the ground. Erosion is a form of detrimental displacement. The majority of erosion occurs by sheet erosion (the even removal of thin layers of soil by water moving across extended areas of gently sloping land) and is difficult to detect, as there are no dramatic effects to alert one to its occurrence. Rills and gullies, however, are dramatic examples of erosion that are easily detected.

Detrimental displacement is routinely mitigated by designating and minimizing the number of skid roads and skyline corridors used; requiring a minimum of one-end log suspension to prevent soil gouging; and placing percent slope limitations on ground-based harvest equipment. Additionally, erosion associated with skid trails and skyline corridors can be effectively mitigated by the placement of cross drains (water bars); drainage dips; placement of down wood and slash; and erosion control seeding (or any vegetative cover on exposed soil). Mitigation measures specifically designed for this project can be found in Appendix B of the DEIS. These measures have been used for many decades and there has been considerable monitoring and demonstration of their effectiveness at reducing or avoiding any negative soils impacts.

Large woody material, such as large logs, and standing snags (future large down logs), are important components in the development and retention of productive soils. Snags are routinely felled if they are believed to be a safety hazard to operations. Operation of logging equipment can mechanically damage/destroy downed logs in advanced stages of decay. Logging and burning has the potential to eliminate these features, particularly those in advanced degrees of decay, from the landscape if care isn't taken to retain them in adequate sizes, numbers, and distribution across the landscape. Project Design Criteria for maintenance of snags and downed wood is located in Appendix B of the DEIS, and such will avoid effects to soil productivity from any changes in levels of snags and down wood.

2. Ground-Based Mechanized Harvesting on Steep Slopes

Advances in ground-based harvest equipment technology are making it more possible to safely operate mechanized felling, pre-bunching, and yarding equipment on steeper slopes (greater than 35%), such as through using self-leveling feller-bunchers or tethered harvester-forwarder systems. Industry has been encouraging these developments to increase operator safety as well as increase production and improve economic feasibility, due to the high costs of conventional cable and helicopter systems (Flint and Kellogg 2013, Visser et al. 2013, Acuna et al. 2011). A study in the Coast Range of Oregon looking at the productivity and cost of six different steep slope harvesting systems found that all steep terrain harvester-forwarder systems had the lowest overall harvesting costs, but also that utilizing a specialized steep terrain harvester which processed and pre-bunched for a cable yarding system, caused an increase in productivity of 79% and a reduction in cost of 58% for the cable yarder (Flint and Kellogg 2013). Similarly, a research trial in Australia found that utilizing a self-leveling feller-buncher to fell and pre-bunch stems for cable yarding on slopes between 36-47%, on dry, sedimentary-based soils with good traction, increased productivity of the cable logging operation (Acuna et al. 2011). While both studies resulted in positive outcomes for economics, neither study examined effects of these systems to soil.

Relatively little research has been done to date, to determine the disturbance effects to soil productivity when utilizing steep-slope harvesting systems. Some reviews of the potential slope

limitations of various ground-based harvest equipment discuss the safe operating range as related to soil bearing capacity and percent slope (Visser and Stampfer 2015, Visser et al. 2013). Soil bearing capacity focuses on the maximum average contact pressure between the load (in this case, the machine), and the soil which should not produce shear failure. However, this should not be equated to the contact pressure that would result in detrimental soil productivity impacts; it is expected that other detrimental effects would likely result in the soil before reaching the point of vehicle slippage and shear failure. Based on their review, Visser and Stampfer (2015) provide guidelines for slope limits for different kinds of ground-based equipment, but these guidelines focus on safety, not impacts to soils, and they recognize that few studies have been done to quantify disturbance. In their economic study, Flint and Kellogg (2013) recognized the importance of considering the potential effects of soil disturbance, not just the economics, of steep terrain ground-based operations.

A recent study in the western Oregon coast range (Zamora-Cristales et al. 2014) evaluated the effects of two systems, a harvester-cut, cable-yarded unit and a harvester-cut, forwarder-yarded unit, on mineral soil exposure and soil strength on slopes averaging 65% and 58%, respectively. Soils were dominated by very gravelly loams. Operations occurred with soil moistures ranging from 30 to 39% (harvester-cable) and 30-36% (harvester-forwarder). The harvester-forwarder system resulted in two, downhill passes on designated skid trails; the harvester-cable system resulted in one, downhill pass on designated skid trails, with logs being cabled uphill. Steep trails represented 15% of the area in the harvester-cable unit, and 10% of the area in the harvester-forwarder unit. Spacing of trails ranged from 18 to 24 m (approx. 60 to 80 ft.) apart. On harvester-forwarder, 7% of the sample points, and 3% of the sample points in harvester-cable, had exposed mineral soil; the statistical analysis of the data generally confirmed that each harvest unit remained below 10% exposed soil. Regarding soil strength, there was no apparent relationship between changes to soil strength and the percent slope, for either system. An evaluation of the relationship between soil strength and slash showed that operating on slash mats resulted in less increase in soil strength over adjacent undisturbed soil, than operating on no slash. When considering the effects of soil strength on forest site productivity, the soil strength on the 2-pass harvester-forwarder unit trails averaged about 2,770 kPa, whereas the single-pass harvester-cable unit trails averaged about 2,096 kPa. Soil strength levels of about 2,500 kPa or higher are considered to start inhibiting vegetation growth on a variety of soils (Page-Dumroese et al. 2006, cited in Zamora-Cristales et al. 2014). These impacts were only seen within the designated trails, which did not exceed 15% of the area in both units. Dry season operations, only 1 to 2 vehicle passes on trails, and an operating system that added slash to the trails and generally limited ground disturbance, as well as skilled operators, are considered factors that contributed to the results of this study.

On the Fremont-Winema National Forest in south-central Oregon, soil disturbance monitoring was completed on a timber sale unit which was thinned in the summer of 2016 utilizing a tethered harvester and forwarder on wheel tracks (Rone 2017). Average slopes in the unit were approximately 20 to 60%, with soils consisting of coarse pumice which were operated on in dry soil moisture conditions. Shortly after harvest completion, soil disturbance monitoring transects identified 9% and 6% in disturbance class 2 and 3, respectively, which in these soil types the soil scientist considers detrimental soil disturbance (G. Rone, pers. comm.). Initial direct soil disturbance was dominated by soil displacement over compaction, which is related to the coarse, non-cohesive properties of the pumice soil in the unit. Some other operational concerns that were observed were machine side tracking and turning impacts, the disintegration of slash mats, and converging and side-by-side skid trails. Monitoring identified multiple recommendations to help

shape project design criteria and mitigations for future steep slope operations, as well as the need to monitor again after a wet season.

The Shasta Agness project is focusing on allowing pre-bunching on slopes greater than 35% but no more than 45%, to assist cable or helicopter yarding, if appropriate equipment and methods are available at the time of implementation. Specifically designed project design criteria and mitigations have been developed to guide the use of this method and assure activities meet soil resource standards and guidelines (refer to Best Management Practices/Mitigation Measures/Project Design Criteria section in Appendix B of the DEIS). Furthermore, future monitoring and/or literature could provide evidence that will determine if detrimental impacts to sensitive soils or unique vegetation habitat types is occurring. The slope stability and soil erosion risk model can also be used to determine suitability for steep-slope harvesting methods by looking at areas rated as moderate (30-60%), however slopes exceeding over 45% will not be permitted.

3. Skyline Cable Systems

Using cables to suspend one or both ends of logs as they are pulled from the stand to the landing largely eliminates the potential for compaction and puddling within the stand. What remains, however, is the potential for detrimental soil displacement if one or both ends of the log are dragged across the ground from the stump to the landing. Full suspension (where the log is lifted entirely off the ground during yarding to the landing) and one-end suspension (where one end of the log is allowed to drag along the ground), are effective mitigations that are now regularly employed to minimize detrimental displacement, as well as the use of a pre-designated skid trail or skyline corridor layout (DEIS Appendix B). Skyline systems typically result in approximately 5% detrimental soil conditions.

4. Aerial Systems

Helicopter logging has the least impact of all logging systems on soil productivity. This is a form of full suspension, with no part of the log being drug across the ground, except for very short distances as logs are lifted off the ground from a central point between logs. Such logging eliminates any potential for equipment-generated detrimental soil displacement, compaction, or puddling and their attendant erosion effects. Helicopter logging does, however, require larger, though fewer landings, with the associated compaction and displacement effects, typically around 2%.

An exception to this is the practice of pre-bunching in helicopter units. Pre-bunching is the short-distance yarding (using small and lightweight yarding equipment) of numerous logs to a reduced number of collection sites within the stand where they would then be picked up by the helicopter. The potential soil benefit is the elimination of skid roads, with their multiple soil compacting and soil displacing passes by heavy equipment with logs in tow; but the practice still induces some level of soil compaction and displacement for short distances in single passes.

C. Activity Fuel Treatments and Adaptive Fire Re-entry

Activity fuels treatment refers to the slash and accumulated fuel resulting from the proposed density management treatments. Natural fuels are fuel accumulations which have built up in the project planning area over time. Several methods of activity fuels treatment throughout the process (pre- and post-vegetation treatments) of restoring unique habitat ecosystems and late-seral acceleration are being proposed. In addition, adaptive fire re-entry is recommended. These include the following: pruning, pile and burning at landing sites, whole-tree yarding, prescribed

fire following variable density thinning (including additional burn of identified area outside and between natural and managed stands).

Project Design Criteria and Mitigation Measures that have been designed for the Shasta Agness Project (DEIS Appendix B), including applicable best management practices in the National Core BMP Technical Guide (USDA, 2012), as well as Regional and Forest level Standards and Guidelines, have influenced the planning of fuels treatment activities during project development, and would be implemented to minimize impacts of fuels treatments on soil productivity.

1. Prescribed Fire/ Pile and Burning

Heat produced during the combustion of aboveground fuels (i.e., dead and live vegetation, litter, duff) is transferred to the soil surface and downward through the soil by several heat transfer processes (radiation, convection, conduction, vaporization, and condensation). As heat is transferred downward into and through the soil, it raises the temperature of the soil. The greatest increase in temperature occurs at, or near, the soil surface. Within short distances downward in the soil, however, temperatures can rapidly diminish so that within 2.0 to 3.9 inches (5 to 10 cm) of the soil surface the temperatures are scarcely above ambient temperature (Neary et al. 2005).

Typical physical effects to soil that can occur from fire include changes to soil structure (particularly as a result of loss of organic matter), changes in porosity and bulk density, loss of cover (i.e., canopy, litter, duff), water repellency, and runoff and erosion vulnerability.

Organic matter plays a key role in soil structure in the upper part of the mineral soil at the duff-upper A-horizon interface, in that it acts as a glue that helps hold mineral soil particles together to form aggregates. Fire can impact the organic matter content in soil by killing the living organisms at temperatures as low as 122 to 140°F, and by destructively distilling to completely consuming nonliving organic matter at temperatures of 224°F and 752°F, respectively (Neary et al. 2005).

Loss of the organic matter component in the soil breaks down the soil structure, which in turn results in a reduction in the amount and size of soil pore space. When the soil structure collapses, it particularly reduces the amount of macropore spaces, and increases the bulk density of the soil, resulting in a loss to soil productivity.

When fire results in the loss of canopy, litter, and duff cover, it exposes the mineral soil to erosion processes. The litter and duff layers also act as an insulator that protects the underlying soil layers from heating, and if they are consumed, it exposes the mineral soil to greater soil heating impacts. Fire-induced water repellency may occur when combustion of organic matter vaporizes hydrophobic organic substances that then move downward in the mineral soil and condenses into a water repellent layer. This in turn increases risk of soil erosion. Water repellent layers have the greatest impact within the first year after fire, as they tend to break down fairly quickly.

Typical chemical effects to soil that can occur from fire include nutrient losses, cation exchange capacity loss, and changes to pH. Nitrogen is the most limiting nutrient in wildland ecosystems, and as such requires special consideration when managing fire. Nitrogen loss increases with increasing temperatures through volatilization, with no loss of N at temperatures below 392 degrees Fahrenheit all the way up to complete loss of N at temperatures above 932 degrees Fahrenheit (Neary et al. 2005). The amount of N lost is generally proportional to the amount of organic matter combusted, and burning during moist litter and soil conditions have shown a

decrease in the amount of total N lost compared to dry conditions (DeBano et al. 1979; cited in Neary et al. 2005).

Nitrogen that is not volatilized either remains as part of the unburned fuels or it is converted to highly available $\text{NH}_4\text{-N}$ that remains in the soil (DeBano et al. 1979; Covington and Sackett 1986; Kutiel and Naveh 1987; DeBano 1991; cited in Neary et al. 2005). This temporary increase in fertility from available N is usually short-lived and is quickly utilized by vegetation within the first few years after burning (Neary et al. 2005).

The cation exchange capacity of soil can be impacted by fire through the destruction of organic matter. The negatively charged particles of organic matter adsorb otherwise highly soluble positively charged cations, which prevents them from being leached out of the soil. As the amount of organic matter is destroyed from fire, so too is the soil's cation exchange capacity.

Cation nutrients (i.e., Ca, Mg, Na, K, NH_4) become concentrated in the ash following fire, and can be lost in several ways such as volatilization (but this takes very high temperatures), particulate loss in smoke, runoff and erosion, and there can be a long term loss of cations to leaching due to the soil's reduction in cation exchange capacity. Cation exchange capacity rebuilds over time with new accumulation of organic matter. The release of soluble cations from the organic matter during combustion can temporarily increase soil pH, but this is dependent in part upon the amount and chemical composition of the ash. Thick layers of ash (termed the ash-bed effect) found from severe burning conditions tends to have the greatest impact on raising soil pH.

Typical biological effects to soil that can occur from fire include loss of microorganisms, loss of meso- and macrofauna, and loss of roots and reproductive structures such as seed banks. Impacts from fire to microorganisms as well as their recovery can be very complex because so many variables are involved. In general it can be stated that "intense wildfire can have severe and sometimes long-lasting effects on microbial population size, diversity, and function", whereas at the other end of the spectrum, "low-severity underburning generally has an inconsequential effect on microorganisms." (Neary et al. 2005). This range of effects is in part related to the amount of organic matter impacted by fire, and the temperature and depth of soil heating. If both of these can be minimized, so would impacts to the microbial population in the soil. Effects of fire to meso- and macrofauna, such as mites, insects, and earthworms, is also highly variable, depending in part on species, habitat and adaptations.

Whether or not plant roots and seed banks are destroyed by fire depends on how deep in the soil they reside, the fire severity and amount of soil heating, and the moisture content of the plant tissues and the soil. Higher moisture content tends to lower the temperature at which living biomass can be killed. Plant tissue can be killed at as low as 104°F , and seeds can be killed at as low as 122°F .

Moist soil is a better conductor of heat into the soil so lethal temperatures may extend deeper into the soil surface. However, high moisture content in the litter and duff aids in facilitating a low severity underburn, which results in very little impact to roots and seeds except at the very surface of the litter layer.

Pile/concentrated slash burning increases the residence time of the fire due to concentrated fuels, which can lead to more consumption of organic matter, higher soil heating temperatures, heating deeper into the soil profile, and thus resulting in isolated patches of severely burned soils directly under the slash pile. Mitigations minimizing to the extent possible the size of the piles and burning during moist soil moisture conditions can reduce these impacts by keeping burn

temperatures and soil heating as low as possible. Smaller burn scars tend to recover quicker as well due to the high amount of un-impacted soil around them that contribute to recolonization of soil microorganisms and other soil biota.

The 1998 Regional Supplement to the Forest Service Manual (FSM 2520 R-6 Supplement 2500-98-1, Effective August 24, 1998) defines detrimentally burned soil as:

“The condition where the mineral soil surface has been significantly changed in color, oxidized to a reddish color, and the next one-half inch blackened from organic matter charring by heat conducted through the top layer. The detrimentally burned soil standard applies to a contiguous area greater than 100 square feet, which is at least 5 feet in width”.

Burning of hand slash piles should not exceed the detrimentally burned soil standard since individual burn piles are designed to be discontinuous and not greater than 10 feet in diameter. Even if these burn scars are taken into account, it is expected that less than 2 percent of the area would be left in a severely burned condition.

Detrimental burning occurs when high intensity fire consumes organic matter above and within the soil, heating the soil to the point where the mineral soil surface changes color and the next one-half-inch deeper of soil organic matter is charred. This can happen under natural high-intensity wildfire conditions or by management actions beneath burn piles or ‘prescribed burns’ when the prescriptions are applied incorrectly or “escape” the parameters of their prescription and become overly intense.

Detrimental burning is most likely under extreme fire weather and dry fuel moisture conditions where fuel accumulations are greatest. Reduction of this fuel through management action decreases the potential of high intensity fire and detrimental burning of the soil. In areas where fuels have been treated (reduced), it is common to have only approximately 20% of the soils in a wildfire-burned area to be in a detrimentally burned condition; this is half of what has been observed in areas where fuels had not been treated.

Large woody material, such as large logs, and standing snags (future large down logs), are important components in the development and retention of productive soils. Burning has the potential to eliminate these features, particularly those in advanced degrees of decay, from the landscape if care isn’t taken to retain them in adequate sizes, numbers, and distribution across the landscape. However, burning also can create snags and down wood and is an important part of the decay process. PDC, BMPs, prescriptions for decadence, and burn plans managing fire intensity would avoid and minimize meeting any threshold of detrimental soil impacts.

The purpose of fuel management activities in the Shasta Agness project is to reintroduce fire into a historically fire-adapted landscape, and to make the ecosystems within the area more resilient to impacts from fire over time. Effects to soils from these activities are expected to therefore be within the natural range of variability expected in these fire-adapted ecosystems.

2. Whole Tree Yarding

This treatment requires that the top of the tree be yarded to the landing along with the last log (or whole tree if small enough). In some small tree cases, this practice may mitigate the potential for detrimental soil displacement from the dragging log end as the limbs of the top cushion and elevate that end and prevent soil gouging and displacement.

With the increased interest in harvesting biomass, there has been an increased need to understand how removing the branches and needles from the site might be affecting short and long-term soil productivity. Most studies have been based on models and/or nutrient budgets which forecast likely effects; however long-term field studies have also been started. In a review of literature regarding the effects of whole tree harvesting on soil productivity, Farve and Napper (2009) refer to a summary of effects by Waring and Running (2007: 214) that found that “a whole-tree harvest can remove as much as three times the nutrients as compared to a conventional bole-only harvest....however, since the soil nutrient (belowground) pool contains most of the nutrient capital of a forest ecosystem (by several orders of magnitude), in general, removal of the whole tree during timber harvesting should result in only a small percentage of nutrient loss from the forest ecosystem.” With implementation of the Shasta Agness Project, where only a portion of trees within a stand are being removed instead of all the trees, the impacts of leaving tops attached is expected to be even less, and likely immeasurable.

D. Aquatic Habitat Improvements

Stream enhancement activities would include the placement of large wood (LW) into stream channels, alcove creation, and floodplain re-connectivity to alter channel morphology by increasing channel stability, pool formation, capture and deposition of in-channel gravels, development of low velocity areas, and improvement of floodplain function to improve fish habitat. Log placement could involve the use of cable, ground based equipment, horses, or helicopters, or felled directly into the stream. Log placement activities could involve the localized disturbance of soil, particularly when logs are buried into the stream bank, and where access is needed by ground based equipment.

Commercial thinning in Riparian Reserves would occur within the Riparian Treatment zone which is approximately 2/3 of the total defined Riparian Reserve (one site potential tree height from the stream channel, each side), excluding the Primary Shade Zone. Thinning within riparian areas would speed the development of residual trees into LW that could enter streams in the future and maintain and restore the sediment regime under which aquatic ecosystems evolved. Any potential detrimental impacts to soil productivity, and organic matter and large woody material through changes to vegetation have been evaluated specifically for Riparian Reserves to ensure only small, isolated short-term effects. Potential short term effects would consist of soil displacement, compaction, and erosion (i.e. reduced ground cover). However PDCs such as maintaining effective ground cover (60 percent to 85 percent) and limiting soil detrimental disturbance to 15 percent or less would limit or avoid measurable levels of soil disturbance in these reserves. Disturbed areas would be minimized and restored through the application of Design Criteria and mitigation measures for operating in riparian reserves.

Aquatic passage barrier removal has been proposed on NFS road 2308330, which crosses Snout Creek. There are seven additional streams that will also need site verification to identify if fish passage restoration is needed. A GIS analysis intersecting roads and streams identified with fish habitat estimated approximately 8 stream crossings (i.e. potential aquatic passage barriers) along FSR 3300000, 3700000, and 3730010. The range of treatments includes: total removal of culverts or bridges, or replacing culverts or bridges with properly sized culverts and bridges, replacing a damaged culvert or bridge, and resetting an existing culvert that was improperly installed or damaged; stabilizing and providing passage over headcuts; removing, constructing (including relocations), repairing, or maintaining fish ladders; and constructing or replacing fish screens for irrigation diversions. Such projects will take place where fish passage has been partially or completely eliminated through road construction, stream degradation, creation of small dams and weirs, and irrigation diversions. Equipment such as excavators, bull dozers, dump trucks, front-

end loaders, and similar equipment may be used to implement projects. Compliance reviews to evaluate if the objectives, project design criteria, and mitigation measures for the soil and geology resources defined in the Shasta Agness project are adhered too will be completed prior to implementation. Potential effects to soils from the removal of aquatic barriers would consist of short-term, localized erosion and displacement from heavy equipment. Application of design criteria and mitigation measures is expected to prevent detrimental soil conditions from these activities.

There would be no detrimental effects from beaver reintroduction and/or beaver dam analogues (BDA) to soils. Beaver reintroduction and/ or BDAs may affect hydrologic processes, which can be referenced in the Hydrology report (Appendix B).

E. Sustainable Recreation

1. Campground Decommissioning, Construction, and Structural Improvements

Campground activities consist of the addition of structural facilities, upgrades to sanitary systems, campground development, campground decommissioning, expansion of an existing parking area, and improvements to access roads. Slope stability would not be an issue since all proposed campground improvement activities are on gentle topography located on flats and outside and above the steeper canyon walls within the planning area. Campground improvements, with the exception of campground decommissioning, would be dedicating the soils purpose to recreation use instead of supporting forest vegetation. This would mean a direct effect to soil productivity. In contrast, campground decommissioning activities would rehabilitate and restore: surface organics to exposed soils, break up compacted layers to improve infiltration rates, and allow revegetation of heavily disturbed areas due to recreational use. A combination of methods similar to road decommissioning to restore the ecological processes of the area would be implemented. (See Direct and Indirect Effects Common to All Action Alternatives). Such actions are likely to produce short-term erosion from newly exposed soils, but long term benefits of re-established site productivity over a quicker timeframe than what would typically be achieved with passive restoration.

2. Trail Construction, Reconstruction, and Decommissioning

Trail construction, reconstruction, and decommissioning activities have the potential to affect soil productivity and slope stability. More specifically trail activities impact the soil resources through actions that reduce effective ground cover, displace soil, cause soil compaction or otherwise negatively impact soil structure, destabilize slopes, and change nutrient cycling processes through vegetation, organic matter and down wood manipulation.

Through construction and subsequent use over time, soils within trail treads become compacted (i.e. bulk density increases). The level of change in bulk density from natural condition can vary depending on soil textures, and level and type of use. Due to the loamy textured soils in the Action Area there is a susceptibility of compaction when soil moistures are high. However, considering the narrow (average of 2 to 3 feet wide), linear nature of the compaction over the landscape, adjacent vegetation is not negatively impacted enough to measurably affect site productivity along trails, particularly at a level that would be considered detrimental. Compaction does not cover a large enough area to impact the productivity of adjacent vegetation. If the trails stopped being used, the narrowness of the compaction along the trail length would be broken up over time through growth of roots from adjacent vegetation into the subsoil of trail

treads. Organic matter is typically mostly uniform across the ground and is present except for where annual deposition of overstory litter gets worn away in the active tread of the trail.

User created unauthorized trails range from being fully sustainable to unsustainable (USDA Forest Service 2010b & Ashland Woodlands and Trails Association 2011). Where trails have been developed without proper design features (typically user-created trails), it is common to see soil rutting and soil displacement off the trail tread, particularly where trails are descending steep slopes, and are located in sandy, coarse textures, and contain very low clay content. In these areas the naturally erosive nature of the soils become evident where effective groundcover has been lost, and water is channelized down steep bare slopes within the trail treads, causing rilling and gullyng. The loose, non-cohesive nature of the soils makes them very susceptible to displacement on steeper slopes from foot traffic. Multiple trail treads form as users create new paths to avoid deeply rutted trails. This trail braiding and subsequent expansion of exposed soil has the potential to increase erosion and loss of organic matter to a level that could be considered detrimental.

Rehabilitation of trails proposed to be decommissioned would restore surface organics to exposed soils and stabilize eroding soils. Site productivity would improve and become restored over time as litter and vegetation reclaim the disturbed areas.

3. Off-Highway Vehicle Use Trails

The development of off-highway vehicle use trails have the potential to impact soil productivity and soil stability. More specifically OHV trail activities impact the soil resources through actions that reduce effective ground cover, displace soil, cause soil compaction or otherwise negatively impact soil structure, destabilize slopes, and change nutrient cycling processes through vegetation, organic matter and down wood manipulation.

The study, *Effects of All-Terrain Vehicles (ATV) on Forested Lands and Grasslands* (USDA 2008), evaluated the impacts to soils based on a matrix of three disturbance classes (low to high) for: litter and vegetation, trail width (both tread and displaced material), and ATV rut depth (Figure 13). The study was conducted in seven locations, which targeted four ecoregions: Desert, High-elevation Western Mountains, Gulf Coastal Plains, and Eastern Broadleaf (USDA 2008). In addition, the Water Erosion Prediction Project (WEPP) model was used to determine the infiltration and erosion characteristics from the ATV study. The study's objectives were to answer three questions: Are natural resources being affected by ATV traffic on forested lands, if so, by how much; and does the way an ATV is equipped make a difference (USDA 2008)?

The results from the study found that natural resources could be adversely affected by ATV traffic, though no significant differences in impacts from the vehicles or tires used were distinguishable (USDA 2008). Vegetation was reduced by a minimum of 40 percent and more often was completely eliminated as a result of ATV traffic at the test sites (USDA 2008). Soils, excluding sands and gravels, were compacted, displaced, or loosened, increasing erosion (USDA 2008). In addition, runoff and sediment generated on the ATV trails increased by 56 percent to 625 percent, respectively, compared to the undisturbed forest floor; furthermore on freshly disturbed soils ATV trails produced on average 10 times more sediment than undisturbed soils (USDA 2008).

However, the levels of disturbance can be reduced by proper trail design and maintenance and by focusing efforts on trail sections that require extra attention, such as curves, and uphill and downhill sections of the trail (USDA 2008). Additionally, Project Design Criteria and Mitigation Measures that have been designed for the Shasta Agness planning area (DEIS Appendix B), including Best Management Practices (BMPs) for trail activities in the National Core BMP Technical Guide (USDA FS, 2012) and the Region 6 General Water Quality Best Management Practices (USDA FS, 1988) would be implemented to minimize and avoid resource damage to soils by OHV activities.

Figure 13. Trail disturbance class matrix (USDA 2008).

	Low Disturbance	Medium Disturbance	High Disturbance
Litter and vegetation	0- to 30-percent ground cover loss, small roots exposed, rocks no more exposed than natural conditions.	30- to 60-percent ground cover loss, small roots exposed and broken, rocks exposed and fractured.	Greater than 60-percent ground cover loss, large roots exposed and damaged, large rocks worn around or displaced.
Trail width (both tread and displaced material)	54 inches or less.	Between 54 and 72 inches. Some trail braiding. Evidence of width increasing.	72 inches or greater. Braided trails evident. Trail width is growing.
ATV rut depth	Ruts less than 3 inches deep.	Ruts 3 to 6 inches deep.	Ruts greater than 6 inches deep.
TOTALS			

F. Roads

1. National Forest System Roads and Maintenance

Road building in forest land is widely recognized as one of the primary causes of debris avalanches in managed forests (Sidle, 1980). Roads change the surface and subsurface water flow patterns, which can cause concentrations of flow and soil saturation where it didn't exist before, leading to a slope failure. Roads have the potential to accelerate slumps, earthflows, and possibly creep landslides (Megahan, 1986). The added weight of fill material on steep slopes, combined at times with improperly routed water that causes saturation of the fill slope, often results in eventual failure. Also road cuts in steep, unstable terrain can trigger debris avalanches by removing downslope support.

Road maintenance provides an opportunity to minimize risk of slope failures along road prisms, by providing proper drainage, and recognizing and improving areas that are recognized to be at risk of failure. Project Design Criteria and Mitigation Measures that have been designed for the Shasta Agness planning area (DEIS Appendix B), including Best Management Practices (BMPs) for road activities in the National Core BMP Technical Guide (USDA FS, 2012) and the Region 6 General Water Quality Best Management Practices (USDA FS, 1988), have influenced the planning of road activities during project development, and would be implemented to minimize impacts of roads on slope stability. Road reconstruction, such as that required at Billing Creek crossing (FSR 3730060), also would help reduce longer-term slope instability and address fillslope failures that exacerbate mass wasting. This reconstruction would be a component of all action alternatives.

2. Temporary Roads and Landings

Construction of temporary roads (and their associated landings) detrimentally compacts soils and contributes to erosion by allowing water to run overland rather than naturally infiltrating at the point of raindrop impact. Roads are an example of detrimental soil compaction with adverse indirect impacts on water movement pathways. Properly designed and constructed roads (including temporary roads) require structures for channeling this now-redirected water flow to desired locations. Temporary roads and landings are expected to have an irretrievable reduction in soil productivity since they are bladed (soil is mixed and displaced) and compacted. Once rehabilitated, the hydrologic function of the soil profile may be re-established, but the soil profile in relation to organics and nutrient cycling is modified to a degree that may take many decades to return to the productive state of the undisturbed forest soils adjacent to it. Landings also, with their likely deep compaction, and soil mixing from construction and recurrent disturbance are expected to cause an irretrievable decrease in soil productivity. Nonetheless, their use is temporary, with the expectation that following use they would be returned to the highest degree of productivity reasonably achievable. The Siskiyou National Forest Plan establishes that no more than 15 percent of an activity area should be compacted, puddled, or displaced upon completion of a project, including roads and landings (but not counting permanent facilities including recreation facilities).

3. Temporary Roads Located on Existing Non-System Road Template

Temporary roads located on existing non-system road templates (often the result of prior harvest activities and logging systems) have resulted in detrimental disturbance and decreased site productivity through mixing, displacing, and compaction. By re-using these routes as temporary roads where feasible during project implementation, instead of creating new templates or disturbance footprints, the area of new detrimental soil disturbance would be minimized. Though the re-use of these templates may set back the natural recovery occurring within the prism, the post-harvest obliteration or decommissioning of the routes would allow the proper methods to be used to set the soils on a trajectory of recovering soil productivity. The reconstruction of these routes as needed to support harvest or treatment equipment would be similar to the effects discussed above under 'Classified Road Maintenance and Reconstruction'.

G. Post-Harvest Treatments

1. Soil Restoration

Subsoiling is a restoration/rehabilitation practice that involves shattering a compacted layer of soil by drawing subsoiling shanks through the soil just below the compacted layer, without turning over or tilling in the surface soil layers. This practice targets compaction that has developed deeper in the soil profile, typically 12 to 22 inches below the surface, and fractures compacted soil to improve water infiltration, eliminate surface erosion from runoff, and encourage root growth of native vegetation over time (Archuleta and Baxter 2008; Kees 2008). Immediately after implementation, the loosened soil may be more susceptible to localized erosion. However, the risk is mitigated through use of a broken surface pattern and application of slash where possible, to increase surface roughness and reduce raindrop impacts.

There are many different variations of equipment that have been developed for subsoiling, many of which were originally developed for agricultural applications and involve pulling subsoiler shanks behind a tractor, or the use of a dozer-mounted ripper system (Archuleta and Baxter 2008; Kees 2008).

These systems can be limited in their effectiveness in forested areas however due to uneven terrain, variations in soil depth and rock content across a treatment area, and the need for maneuverability around remaining trees and other vegetation. The recommended subsoiling equipment for the Shasta Agness project planning area would be use of a single or two subsoiling shanks with coulter blades, mounted on an excavator and with the capability to also be able to pick up and spread woody debris across the treatment area, similar to the designs in Archuleta and Baxter (2008) and on the USDA Forest Service Technology and Development Program website (http://www.fs.fed.us/t-d/programs/forest_mgmt/projects/subsoiling/).

Subsoiling equipment mounted on an excavator has been used with success on the Gold Beach Ranger District for soil restoration, where historic management methods created detrimental compaction. In addition, located in the appendices soil characteristics shows the “high restoration” potential of the soils within the oak and pine units proposed for treatment.

Management actions such as subsoiling and providing coarse woody material (where the site is deficient), in combination with natural processes such as frost heaving and root growth, can accelerate the rate of rehabilitation in areas of detrimental compaction or disturbance. Though successful to a degree, it is not expected that these actions would return these soils fully to their original condition and function.

Subsoiling can restore some degree of soil permeability to compacted soils. Some areas, however, may not be fully reparable by subsoiling. Compaction in these areas may be deeper than subsoiling equipment can reach and is the result of operating heavy equipment with high contact pressure (pounds per square inch on the soil surface) under wet conditions. Other areas may contain too many large boulders to effectively break up the compaction with the tool available. Such areas are not identifiable above ground and use of old skid trails there could set back any vegetative recovery from past management. However, subsoiling these areas may still improve on the past compaction, though not as effectively as soils with shallower compaction layers and fewer boulders.

2. Planting

Planting trees in openings created by vegetation restoration treatments or small group selection would have no adverse effect on soil productivity. The planting work would be by hand, with the only effect being the minimal displacement caused by the tree planter at each individual planting site. There could be a very modest beneficial long-term effect concerning precipitation interception as discussed above by establishing forest cover on the site faster than might naturally occur. Therefore, the effects of planting will not be discussed further in this analysis.

3. Pre-commercial Thinning and Wildlife Habitat Enhancements

These actions have no measurable direct or indirect effect on soil productivity, detrimental disturbance, or organic matter because activities implemented for pre-commercial thinning would be handsaw work and cutting of small trees and brush in the midstory or understory of areas. Methods to execute wildlife enhancements include: girdling, topping and de-limbing, and inoculation. No heavy equipment would be used to implement pre-commercial thinning or wildlife enhancements.

4. Road Decommissioning

As discussed above under temporary roads, road decommissioning has the goal of removing the road from a usable state for motor vehicles and restoring the site to some degree of productivity

for forest restoration. Existing conditions of these roads vary greatly, with some already naturally closed and soil restoration well advanced, where all that is needed for restoration is installation of an effective closure. In such cases, mechanical treatment could be more of a setback for soil productivity than a benefit.

Some roads are just the opposite, where mechanical treatment is necessary to make the road impassable, and to break up the compacted layers to improve permeability and facilitate tree root growth deeper into the soil profile. Such actions are likely to produce short-term erosion from newly exposed soils, but long term benefits of re-established site productivity over a quicker timeframe than what would typically be achieved with passive restoration.

5. Soil Organic Amendments

Mechanical site preparation in forests often results in soil compaction, mixing of forest litter with mineral soil, and/or displacement of surface organic material in forest ecosystems (Diacono and Montemurro 2010; Tan and Chang 2007). However, scientists and land managers have studied the impairment left on resources from past management activities. These findings and observations have helped develop protective measures, which now are more formally known as standard and guidelines, project design criteria (PDC), mitigation measures, and best management practices (BMP). These have greatly reduced or prevented detrimental impacts to soil and other resources.

In addition to the current standard practices and protection measures taken with treatment activities today, an alternative or in combination, rehabilitation tool that could be used is the addition of soil organic amendments (SOA). SOA is any material of plant or animal origin that can be added to the soil to improve its physical, chemical, and/or biological properties, including water retention, permeability, water infiltration, drainage, aeration, increase in soil carbon, and structure. The use of organic amendments is increasing for soil restoration and vegetation regeneration in frequently burnt or degraded ecosystems (Cellier and others 2014). Therefore, SOA treatments may be used in appropriate areas of prior disturbance such as in candidate plantation units and/or road project activities (storage, decommissioning, or temporary road obliteration). These could include, but are not limited to, nutrient sources such as organic matter, compost, mulch, biochar, straw, etc.

In a study conducted by Diacono and Montemurro (2010), Van-Camp et. al. (2004) found that organic amendments influence soil characteristics by the interdependent modification of biological, chemical, and physical properties. Furthermore, effects from SOA's such as compost may depend on soil characteristics which influence soil properties, as soil texture and pH (Cellier and others 2014).

Furthermore, the primary purpose of Diacono et. al. (2010) research was to examine the effect of different organic amendments on overall soil fertility. Microbiological and biochemical soil properties are very reactive to small changes occurring in management practices, therefore it is possible to use them in evaluating the effects of the application of different sources and amount of organic matter on soil characteristics during experimental trials. (Diacono and Montemurro 2010). However, Diacono and Montemurro (2010) indicated, it is difficult to distinguish between the direct and the indirect effects of an amendment on the behavior of soil microorganisms. For example: soils amended with compost or other raw organic materials can be stimulated such that there is increased endemic microbial activity growth (Diacono and Montemurro, 2010). Another study completed by Lehmann and others (2011) involved the effects of biochar on soil biota. Biochar, when produced, is devoid of biota (Lehmann et. al. 2011). However, during storage or transport inoculation with microbes could occur, which would then be added- potentially

inadvertently- to the target ecosystem (Lehmann et. al. 2011). It is not valid to conclude from positive effects on one organism group that a particular biochar (or soil amendment) will also have similar positive effects on others (Lehmann et. al. 2010). No studies exist in the soil biology literature that recognize the observed large variations of biochar physico-chemical properties. This shortcoming has hampered insight into mechanisms by which biochar influences soil microorganisms, fauna and plant roots (Lehmann et. al. 2011). For all of the action alternatives, some level of naturally-produced biochar would result from the proposed broadcast-burn, prescribed fire components. The area of potential production coverage would be the greatest in alternative 1, followed by alternatives 2 and 3, respectively.

On the other hand, several literature sources were cited in Diacono and Montemurro (2010) that supported SOA to improve chemical and physical soil fertility. Various studies indicated applications increased the organic carbon stock, and therefore increased the cation exchange capacity (Diacono and Montemurro 2010), total number of cations a soil can hold or total negative charge. This allows the nutrient availability to increase for plant uptake. In addition, long-term organic amendments can have a positive role in climate change by sequestering soil carbon (Diacono and Montemurro 2010). Likewise, the physical soil fertility treatments indicated enhancements in aggregate stability impacting soil structure. Improvements to soil structure increase water retention, root growth, decrease in erosion, etc.

Many factors will dictate the response soils have to SOA additions in disturbed areas. For example: quantity and quality of organic amendment, and soil characteristics. However, studies indicate effects observed will mostly have a positive influence to soil productivity by increasing soil fertility. Though, it is likely this will continue to be an area studied, and the effects may be better understood in the coming years.

VII. Environmental Consequences

The **project specific plan amendment** for this project which would allow cutting of trees over 80 years of age within the LSR allocation would not measurably affect soils. Land management activities shall be planned and conducted to maintain soil productivity and stability (USDA Forest Service 1989). To analyze these effects to soil resources, vegetation age is not generally an indicator used to measure detrimental soil conditions. These components are more directly related to percent area disturbed, and is not to exceed 15% of the total acreage within an activity, including roads and landings. The removal of vegetation in stands over 80-years old would still be constrained to the 15% disturbance threshold, as well as other applicable standards and guidelines to protect soil health and productivity. Application of broad-scale conservation objectives, coupled with the implementation of site-level design and protection measures is intended to contain the accrual of detrimental soil impacts that can occur as a result of ground disturbing activities, and limit their extent to an acceptable degree. Together these are the principle means for protecting and conserving soil resources so that long-term site productivity is assured.

A. Project Scale Analysis for Direct and Indirect Effects to Soil Productivity and Stability

1. Spatial Scale

Slope stability effects focus on areas directly within, and upslope and downslope of proposed activities, since slope stability is affected by actions that would occur directly or immediately adjacent to the slope.

Soil productivity effects focus on soils that are directly within proposed activities, since soils are affected by actions that occur directly upon them and not from actions that occur spatially disconnected from them.

2. Temporal Scale

Slope stability short term effects occur within the first 1-3 years; this captures direct impacts from vegetation changes or disturbance that can trigger instability due to changes in precipitation/soil interaction on a site. Long term impacts occur starting at 7 to 10 years; this captures changes in root strength on a slope, as roots from cut conifers decay and can cause shallow groundwater piping, etc., and roots from any remaining trees potentially expand in extent.

Soil productivity short term effects occur within the first 1-5 years, which would include the expected recovery of organic matter and nutrients in soils that have experienced disturbance, such as displacement, erosion, or shallow surface compaction at a level that is not considered detrimental. Long term effects are expected to last 25 years or greater, and refer to soil effects that are considered detrimental, such as deep compaction and extensive displacement and loss of the A horizon.

B. Direct and Indirect Effects Common to All Action Alternatives

1. Road Decommissioning, Storage, and Openings

All action alternatives involve decommissioning and storage of classified roads. The estimated total footprint of action alternatives is provided in Table 2, below the *Introduction*. Proposed road decommissioning within alternatives ranges from 6 to 10 miles, the storage (convert to Maintenance Level (ML) 1) of 4 to 9 miles of classified. Table 13 provides the list of roads and ML recommendation.

These activities would result in the long term restoration of soil productivity and elimination of potential slope failures along proposed decommissioned miles of classified roads for all action alternatives. Treatments would also reduce the potential for slope failures and temporarily improve soil productivity along recommended roads for storage.

Commented [OL-F1]: Change numbers with Barbara's numbers.

Table 13. Road decommissioning and storage proposals for all action alternatives within Shasta Agness planning area.

Road Number	Current ML ¹⁰	ML Recommendation and Alternative Number	Miles of ML change
2300730	ML1	Alt. 1-Decommission (SE portion) Alt. 2-Decommission (SE portion) Alt. 3-Decommission (SE portion)	1.4
2300736	ML1	Alt. 1-Decommission Alt. 2-Decommission Alt. 3-Decommission	0.5
2300770	ML1	Alt. 1-Decommission Alt. 2-Decommission Alt. 3-Decommission	1.0
2300820	ML1	Alt. 1-Decommission (western portion) Alt. 2-Decommission (western portion) Alt. 3-Decommission (entire road segment and spur road 2300824)	Alt. 1 and 2- 0.8 Alt. 3- 1.5
2300860 & spurs (2300864)	ML1	Alt. 1-Decommission Alt. 2-Decommission Alt. 3-Decommission	1.5
2300900	ML1	Alt. 1-Decommission Alt. 2-Decommission Alt. 3-Decommission	0.6
2300911	ML1	Alt. 1-ML1 Alt. 2-ML1 Alt. 3-Decommission	0.9
2300990	ML1	Alt. 1-ML2 (Seasonal closures)/Partial Decommissioning to SCC ¹¹ Alt. 2-ML2 (Open year round) Alt. 3-Decommission (Entire road segment)	Alt. 1- 0.4/0.2 Alt. 2 and Alt. 3- 0.7
2308260	ML1	Alt. 1-Decommission(Partial 590-ft at end) Alt. 2-Decommission Alt. 3-Decommission	Alt. 1- 0.1 Alt. 2 and 3- 0.3
3577350 & Spurs (3577357)	ML1	Alt. 1-ML1 Convert to OHV use Alt. 2-ML1- Convert to OHV use Alt. 3-ML1 (Storage)	3.9
2300475	ML2	Alt. 1-ML1 Alt. 2-ML1 Alt. 3-ML1	0.7
2300995	ML2	Alt. 1-ML2 Alt. 2-ML2 Alt. 3-ML2	0.2
2308330	ML2	Alt. 1-ML1 Convert to OHV use Alt. 2-ML1 Convert to OHV use Alt. 3-Decommission	0.7
3700190	ML3	Alt. 1- ML2 (Only administrative use) Alt. 2 – ML3 Alt. 3- ML2 (Only Administrative use)	1.4
3336070 & spurs (3336071, 3336072, 3336073, 3336074, 3336075, 3336076, 3336077, 3336079)	ML2	Alt. 1-ML1 Alt. 2-ML2: 3336070, 3336071, 3336072, 3336074, 3336075, 3336076, 3336077, 3336079); ML1- 3336073 Alt. 3-ML1	Alt. 1 and 3- 4.2 Alt. 2- ML2: 4.2; ML1: 0.4 Alt. 3- 4.2
3730010 (split)	ML2	Alt. 1-North portion: ML1 Alt. 2-ML2 (Maintain entire road length) Alt. 3-ML2 (southern portion)	Alt. 1- 0.7 Alt. 2- 1.5 Alt. 3- 0.8

¹⁰ ML: Maintenance Level

¹¹ Shasta Costa Creek

5325520 & spurs (5325523 and 5325525)	ML2	Alt. 1-ML1 Alt. 2-ML1 Alt. 3-ML1	2.8
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Road treatments completed for decommissioning and storage would vary with the field conditions observed during implementation. Potential treatments include any combination of the following potential actions:

- Drainage structures (i.e. culverts, cross drains, etc.) are removed;
- Shaping stream crossings to natural channel dimensions;
- Shallow ripping;
- Deep subsoiling using a specifically designed subsoiler implement, mounted on a – tracked excavator;
- Partial to full roadfill pullback/recontouring;
- Road is blocked to further use, and road is returned to vegetation production through revegetation (seeding, planting browse species, or hardwood/conifer trees);
- Water-barring; and
- Installing rolling dips.

2. Classified Road Maintenance and Reconstruction

Existing system roads are considered a long-term commitment of the soil resource to something other than soil productivity, maintenance and reconstruction would have no effect to the current condition of the soils that are committed to supporting the transportation system. However, where system roads have been closed for a period of years, some level of road reconstruction and maintenance would be necessary to make them suitable for treatment access. Road reconstruction of a degraded road generally requires the removal of vegetation and the reshaping of the former road prism, possibly including ditches. The road may have achieved some degree of restoration from past use, but whatever that degree, reconstruction would reverse the degree of restoration. Reconstruction of these routes, however, has far less impact to soil productivity than to native soil sites. Reconstruction of existing roadbeds are less detrimental to soil productivity than new construction.

In addition, during maintenance and reconstruction activities, some temporary and short-term soil erosion could occur. Best management practices and mitigation measures have been developed that are highly effective at minimizing these effects, and would be implemented to greatly minimize erosion and the movement of sediment from these activities. Any potential effects are expected to be localized and short-term in duration.

a) Slope Stability

Road decommissioning, openings, storage, OHV access, and stream crossing improvement on these identified roads provide an opportunity to minimize risk of slope failures along road prisms, by providing proper drainage, and recognizing and improving areas that are recognized to be at risk of failure. For example, the decommissioning of FSR 2300860, as shown above in Figure 4, would eliminate the potential for a larger fillslope failure to occur and the potential for greater amounts of sediment delivery to enter an unnamed tributary, which directly flows into Shasta Costa Creek.

Project Design Criteria and Mitigation Measures that have been designed for the Shasta Agness project area, including best management practices (BMPs) for temporary and classified road activities in the National Core BMP Technical Guide (USFS 2012) and the Region 6 General

Water Quality Best Management Practices (USFS 1988), have influenced the planning of road activities during project development, and would be implemented to reduce or eliminate potential future risk on classified roads to be decommissioned, put into storage, and storm proofed at stream crossings.

b) **Soil Productivity**

Classified road decommissioning would involve taking the road off the classified road system and restoring the roadbed to more natural site conditions. Roadbed restoration activities are described above for both decommissioning and storage. No ground disturbing actions may be needed where a roadbed is already on a successful passive restoration trajectory.

Road decommissioning provides the opportunity for soils that have been committed to something other than site productivity, to begin to redevelop and support a vegetation community again. While short term effects to soils can include a temporary increased risk of erosion due to loosening the soil, through breaking up deep compaction, water infiltration and gas exchange processes can be renewed, roots are able to penetrate deeper into the soil profile, and soil microbial and nutrient cycling communities and processes can begin to get re-established, resulting in soil productivity restoration over the long term.

“Storage” converts an open, classified road to Maintenance Level 1, closed and puts the template into storage. Putting a classified road into storage still commits the soil resource to something other than soil productivity over the long term. However, eliminating regular use of the road reduces the potential for surface erosion, as organic matter builds up on the road prism. Over time with continued closure, some shallow rooted vegetation is able to establish in the road prism and temporarily improve productivity, until the road is re-opened.

Stormproofing stream crossings would improve the hydrologic function of these systems and reduce or eliminate the potential for fill failures at the crossings during high flow events, which would reduce or eliminate the potential domino effects of downstream inner gorge slope failures or mass wasting that can occur when road crossings blow out.

Road openings would convert a Maintenance Level 1 road to Maintenance Level 2. Opening of the roads would eliminate the passive restoration that has been taking place since the roadbed was placed into storage. However, because the road was not decommissioned and placed into storage the soil resource is still committed to something other than soil productivity over the long-term. Potential short term effects would be similar to road reconstruction activities. Approximately 1 mile of road is proposed to be reopened under Alternative 1 and 2. Under Alternative 3 there would be no effects, since reopening of the road would not occur.

3. Naturally Occurring Asbestos

The temporal boundary for effects consideration is during ground disturbing activities that generate dust, plus about 10 minutes for dust settlement. The spatial boundary for effects consideration is the immediate disturbance area or road bed, plus 100 feet on either side, because that is all the further the asbestiform mineral dust is likely to travel.

Natural weathering and routine human activities may disturb asbestos-bearing rock or soil and release asbestos fibers into the air. Examples of dust-generating activities include, but are not limited to: recreational activities on unpaved roads, trails, or soils where dust may be generated, such as riding off-road vehicles, riding bicycles, running or hiking; timber harvest activities; and temporary road construction activities. Within all of the action alternatives, Nancy Creek Trail is

the only trail that crosses soils characterized by serpentine soils. In addition, approximately 0.7 miles of the trail length is within this area. During restoration thinning, PDCs requiring slash mats and limiting soil disturbance extent would minimize the possibility of exposure. Temporary road segments in units 58, 61, 125, which is equivalent to 0.3 miles of the proposed mileage for temporary roads, include soils characterized by serpentine. On-site inspection would be required to assess the slide potential of serpentine exposures (DOGAMI 1976 in Ochoa 2018). Therefore, these temporary roads would be surveyed and approved as stated in the project design criteria (Appendix B) to avoid potential mass wasting events and effects to slope stability. Additionally, new proposed temporary roads would be both limited in linear extent (less than 5 miles) and restricted to harvest access and use duration; they would be closed and decommissioned after project completion. PDCs and BMPs would dictate their design and implementation on the site-specific scale. Their use would be temporary (less than 1-2 months) and prohibited from public use. This means the number of vehicle passes would be minimal; there is no new proposed access by the public. Vehicle speeds would be slow. Dust mitigation is a requirement for all access in the project area (temporary or existing). The temporary access lengths are short, and speeds would remain low (less than 15 miles per hour). Dust mitigation combined with the slow speeds means that the potential for naturally occurring asbestos to leave the project area is very low. Equipment would be washed before moving to new areas per the botany project design features intended to reduce weed spread, and there are mitigations in place to minimize track-out onto paved roads. More information about how recreational users can avoid exposure is located at: Naturally Occurring Asbestos: What Visitors to National Forests Need to Know: https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5126449.pdf.

C. Direct and Indirect Effects Common to Action Alternatives

1. Alternative 1 (Preferred Alternative)

Unique Landscape Vegetation Treatments

Alternative 1 would treat an estimated 6,726 acres for proposed silvicultural activities, including fuel treatments. In addition, 241 acres of Port Orford Cedar (POC) sanitation would be implemented in high risk areas with no diameter limit restrictions. High risk areas are low-lying wet areas (infested or not) that are located downslope from already infested areas or below likely sites for future introductions, especially roads and streams, are high-risk sites. These harvest treatments would include 3,770 acres of commercial thinning and 2,956 acres of non-commercial thinning. The following describes the estimated total acreage for each logging system: 1,353 acres with tractor systems, 1,473 acres with skyline systems, and 944 acres by helicopter. This includes all of the primary management objectives (develop and enhance late seral habitat (DELSH), restore pine-oak communities, treatment of high risk areas for phytophthora lateralis, and restore riparian reserves). Treatments would involve multiple silvicultural prescriptions, including variable density thinning, hardwood retention, and 2 acre maximum patch cuts. Variable density thinning would be limited to a minimum canopy cover of 40%, except where white oak restoration and oak savannah/woodland release are the main objectives. Target canopy cover for white oak restoration ranges from 0-20%; oak savannah/woodland release treatments would maintain a canopy cover of 20-40%. Fuels treatments would involve pruning, piling, and burning post vegetation treatment, with underburning 1 to 5 years post treatment. Treatment methods would involve a combination of manual (hand) work, and mechanized equipment including ground-based, cable-yarding, and helicopter equipment. It is estimated that approximately 17 miles of temporary roads would be needed to provide temporary access to meet project objectives.

Aquatic and Riparian Habitat Treatments

Desired conditions for riparian areas include speeding the development of residual trees into LW that could enter streams in the future and improvement of shading capabilities to streams.

Alternative 1 would treat approximately 1,582 acres within Riparian Reserves for all proposed silvicultural thinning. These harvest treatments would include 495 acres of commercial thinning and 1,087 acres of non-commercial thinning. The following describes the estimated total acreage for each logging system: 274 acres with tractor systems, 169 with skyline systems, and 197 acres by helicopter. In addition, 52 acres would occur along high risk areas with uninfested Port-Orford-cedar. Approximately, 0.7 miles of non-system road template is needed within riparian reserves to achieve desired conditions of riparian areas.

LW benefits stream hydrology by dispersing energy during high flows, connecting streams to their floodplains, storing and sorting in-stream sediment, and regulating stream temperatures. Alternative 1 has the potential to place LW structures along an estimated 29 miles within the stream channels of Billings Creek, Foster Creek, Lawson Creek, Shasta Costa Creek, Snout Creek, Squirrel Camp Creek, Stair Creek, Twomile Creek, and Waters Creek.

In addition, fish passage restoration has the potential for only minor, short term increases in fine sediment delivered to the stream. Effects from management activities would be limited to small areas of disturbance and be subject to mitigation and erosion control activities. Therefore, the effects would be minimal and short term. Activities would occur during the inwater work windows when turbidity exposure effects to aquatic listed species are reduced.

Sustainable Roads

Alternative 1 road treatments are discussed above in the *Direct and Indirect Effects Common to All Action Alternatives*. Estimated soil disturbance is described in Table 2 and Table 13. Table 2 approximates miles proposed for road decommissioning, storage (ML2 to ML1), road openings (ML1 to ML2), haul routes, and new and existing temporary road construction. Table 13 describes the current maintenance level objective, recommendation for each alternative, and estimated mileage impacted by proposal. In addition, Table 14 describes the estimated acreage of each temporary road proposed.

Sustainable Recreation

Alternative 1 recreation proposed treatments are described in Table 4 and Table 5, below the *Introduction* (estimated in miles and acres). Project activities include: new OHV trail construction, trail decommissioning, campground developments with additional structures, campground decommissioning, boat ramp improvements or construction, and improvements to existing facilities.

▪ **Alternative 1- Slope Stability**

Slope stability can be impacted by management actions, through actions that alter soil holding strength of root systems through vegetation changes, change drainage patterns through soil movement or compaction, or undermining of slopes. Specific activities as related to the Shasta Agness Restoration project include temporary road construction and reconstruction, silviculture treatments, fuels treatments, conversion of classified road systems to mixed vehicle use or OHV use, and instream large wood placement. Figure 14 to Figure 16 displays the slope stability and soil erosion risk mapping within the Alternative 1 proposed treatment units, as well as the proposed road decommissioning, storage, and road conversion to OHV trails.

Silvicultural

It is not expected that there would be an increased chance of slope instability due to the silvicultural treatments (commercial or non-commercial) being planned with the Shasta Agness Project, under any Action Alternative. It is expected that the thinning treatments planned would not reduce the density of remaining live tree roots enough to cause a weakening of the soil-root reinforcement. The remaining trees' root systems would respond to the reduction in competition and expand in the soil profile before the root systems of the cut trees had significantly decayed. The promotion of oaks and other re-sprouting hardwood species increases the long-term effectiveness of vegetation adding to slope stability through their root-anchoring capabilities.

Harvest Logging System Effects

Mitigation measures require that areas of past disturbance, such as previous skid trails and landings, be re-used to the highest extent possible during layout and implementation of new activities. Exactly how much of this past disturbance can be re-used in units that are not extensively impacted from past activities cannot be known for sure until the sale is being laid out. Where a unit is already estimated to be over 15 percent detrimentally disturbed from past impacts, Forest Plan Standards and Guidelines and the Region 6 Manual require that "the cumulative detrimental effects of project implementation and restoration must, at a minimum, not exceed the conditions prior to the planned activity and should move toward a net improvement in soil quality" (USDA 1998). In these units, it is required that no new detrimental disturbance is created, and this requirement guides how the logging system can be laid out and implemented (Appendix B, mitigation measures and project design criteria). These units would benefit from active soil restoration activities to move these sites towards a net improvement in soil quality over time. These total 4 units and include units 217, 218, 233, and 236 (Bearcamp12).

Temporary Roads and Landings

Approximately 17 miles of new temporary and existing non-system road templates and associated landings would be constructed; at an average width of 12 feet, this would result in an estimated 25 acres of soils becoming detrimentally disturbed through increased likelihood in surface erosion, compaction, and displacement. Of the 17 total miles of temporary roads, approximately 12 miles of temporary roads would be constructed on existing non-system road templates. This is an estimate of 17.5 acres. Field observations of old existing non-system road templates find that soil productivity is continuing to recover (i.e., vegetation is growing in the road template, a mat of decomposed litter is forming an O-horizon, and compaction is being reduced by roots and burrowing animals). Temporary use of these templates would remove any soil that has formed, vegetation that has grown, and re-compact the road surface, effectively resetting the soil

productivity recovery process back to conditions that existed when the template was first used. However, this would not result in new detrimental compaction or displacement, as these soils are already detrimentally impacted. These effects would be mitigated as these roads, following use, would be returned to the highest degree of productivity reasonably achievable. Table 14 displays the soils each temporary road segment would cross, and soil disturbance characteristics, and how temporary road construction affects erosion and compaction. Interpretations are from the NRCS Web Soil Survey.

Table 14. Alternative 1- Estimated temporary road acreage, soil map units, soil land management ratings, and potential for restoration.

Unit Number with Proposed Temporary Roads	New, Partial ¹² , or Existing	Approx. Acres ¹³	Soil Map Unit	Erosion Hazard (Road/Trail)	Suitability for Roads (Natural Surface)	Soil Compaction Resistance	Soil Restoration Potential
2	Existing	0.4	61A 197E	Slight; Severe	Well suited; Poorly suited	Moderate Resistance	High Potential
3	Existing	0.5	197E	Severe	Poorly suited	Moderate Resistance	High Potential
4	Existing	1.6	267F 197E 25G	Severe	Poorly suited	Moderate Resistance	High Potential
5	Existing	1.6	267F 197E	Severe	Poorly suited	Moderate Resistance	High Potential
9	Existing	0.6	233F	Severe	Poorly suited	Moderate Resistance	High Potential
10	Existing	2.4	22F 197E	Severe	Poorly suited	Moderate Resistance	High Potential
12	Existing	0.6	267F 25G	Severe	Poorly suited	Moderate Resistance	High Potential
29	New	0.2	33E	Moderate	Poorly suited	Moderate Resistance	High Potential
53	Existing	3.8	9F 197E 8E 9G	Severe	Poorly suited	Moderate Resistance	High Potential
54	Partial	New: 0.1 Existing: 0.1	8E 9F	Severe	Poorly suited	Moderate Resistance	High Potential
58	Existing	0.1	132F	Severe	Poorly suited	Moderate Resistance	High Potential
59	Existing	0.2	90E	Severe	Poorly suited	Moderate Resistance	High Potential
61	New	0.1	53E	Severe	Poorly Suited	Moderate Resistance	High Potential
72	New	0.1	267F	Severe	Poorly suited	Moderate Resistance	High Potential
73	Existing	0.1	197E	Severe	Poorly suited	Moderate Resistance	High Potential
74	Partial	Existing: 0.4 New: 0.2	197E 267F	Severe	Poorly suited	Moderate Resistance	High Potential
76	New	0.9	197E 267F	Severe	Poorly suited	Moderate Resistance	High Potential
79	Existing	1.2	196C 233F	Severe	Moderately suited	Low Resistance; Moderate Resistance	High Potential
101	Existing	1.0	90E 182F	Severe	Poorly suited	Moderate Resistance	High Potential

¹² Partial=Temporary road includes segments that are new and existing.

¹³ Approximate acreage may be greater due to rounding differences.

102	Existing	2.6	73F 182F 91F 80F	Severe	Poorly suited	Moderate Resistance	High Potential
123	New	1.8	240E 90E 91F 54F	Moderate; Severe	Poorly suited	Moderate Resistance	High Potential
125	Existing	0.1	232F	Severe	Poorly suited	Moderate Resistance	High Potential
204	Existing	0.3	8E	Severe	Poorly suited	Moderate Resistance	High Potential
211	New	0.1	233F 25G	Severe	Poorly suited	Moderate Resistance	High Potential
212	Existing	0.1	233F	Severe	Poorly suited	Moderate Resistance	High Potential
214	Partial	Existing: 1.4 New: 0.2	5F 20E 156G 21F	Severe; Moderate (20E)	Poorly suited	Moderate Resistance	High Potential
216	Existing	1.7	265G 124E 265F	Severe; Moderate (124E)	Poorly suited	Moderate Resistance	High Potential
218	Existing	0.2	124E	Moderate	Poorly suited	Moderate Resistance	High Potential
221	Existing	0.5	20E 250F	Severe; Moderate (20E)	Poorly suited	Moderate Resistance	High Potential
224	Existing	0.8	155F 265F	Severe	Poorly suited	Moderate Resistance	High Potential
242	Existing	2.4	245G 265G	Severe	Poorly suited	Moderate Resistance	High Potential

The majority of these temporary road segments would be constructed over soils rated as severe for erosion hazard on roads/trails and moderate resistance to compaction. In addition, soils were generally rated as poorly suited for road construction. *Poorly suited* indicates that the soil of one or more of the properties are unfavorable for the specified kind of roads (natural surface); these properties include: slopes, content of sand, rock fragments on the surface, plasticity index, the Unified classification of the soil, depth to a water table, ponding, flooding, and the hazard of soil slippage (Web Soil Survey: <http://websoilsurvey.nrcs.usda.gov/>).

Temporary road segments in units 58, 61, 125 include soils characterized by serpentine. Serpentinic soils in the planning area are those that are forming in ultramafic peridotite/serpentine parent geologies. These soils include several platy minerals rich in magnesium and iron and analogous to certain clay minerals in structure (DOGAMI, 1976). Mass movement potential varies considerably and includes active mass movement in some areas and stable ground in others (DOGAMI, 1976). On-site inspection is required to assess the slide potential of serpentine exposures (DOGAMI, 1976). Therefore, these temporary roads will be surveyed and approved as stated in the project design criteria (Appendix B) to avoid potential mass wasting events and effects to slope stability.

Although soils indicate sensitivity to road construction and activities, all temporary road segments are on soil types that have a high soil restoration potential, and generally are rated as low on the slope and stability soil risk rating map due to the location (i.e. flat upslope areas or ridgetops). Soil properties were not used in the parameters specified for the slope and stability soil risk model, further explained above within, *Information Sources and Analysis Methods*. This may account for the differences in the ratings between NRCS Web Soil Survey and the Slope and Stability Soil Risk Rating model. Project Design Criteria and Mitigation Measures that have been

designed for the Shasta Agness project, such as limiting use of native surfaced roads during dry soil moisture conditions, would be implemented to minimize impacts of temporary roads on slope stability. Best management practices for temporary and classified road activities in the National Core BMP Technical Guide (USFS 2012) and the Region 6 General Water Quality Best Management Practices (USFS 1988) have influenced the planning of road activities during project development.

Figure 14. Slope stability and soil erosion risk map of the West portion of the planning area, with Alternative 1 units and road proposals.

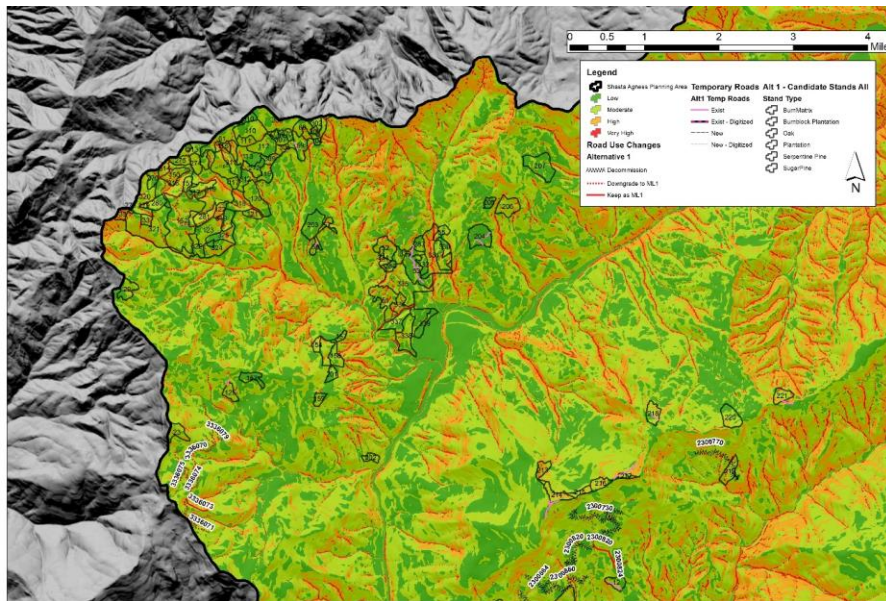


Figure 16. Slope stability and soil erosion risk map of the South portion of the planning area, with Alternative 1 units and road proposals.

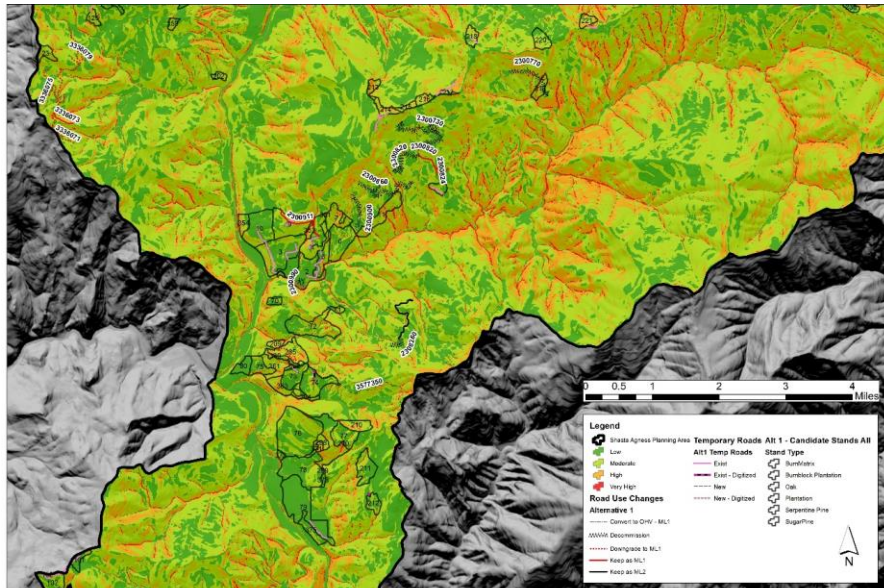
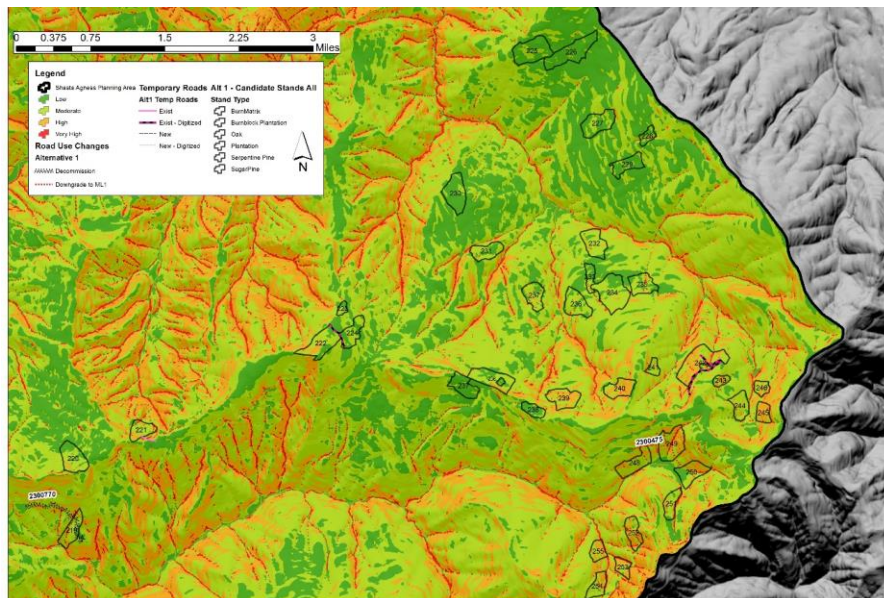


Figure 15. Slope stability and soil erosion risk map of the East portion of the planning area, with Alternative 1 units and road proposals.



Activity Fuel Treatments and Adaptive Fire Re-entry:

Underburning could have similar effects as those described for silvicultural treatments, through changes to vegetation as well as the consumption of surface down wood and litter. However, fuels treatments are designed to maintain the overstory canopy the stands are being managed for, as well as to burn with a mosaic of low severity and unburned fuels. Fuels treatments, including pruning, handpiling and burning, are designed to make stands more resistant to stand replacing wildfire effects, which is the kind of disturbance that would be more likely to increase the risk of slope failures. Based on the fuels treatments proposed, it is not expected that there would be a measurable effect from fuels treatments that would result in an increase in slope failures in the project area.

Instream Large Wood Placement:

Placement of large wood instream structures could potentially have an effect on slope stabilities immediately adjacent to the stream channel, depending on how the structures influence the direction and velocity of stream flows towards or away from toeslopes. However, it is not expected that these structures would be large enough to initiate new instability where none currently exists. The design of the structures is to mimic the composition and distribution of naturally occurring structures in similar stream systems, and because they are lacking in these proposed locations. Therefore it is not expected that implementation of large wood instream structures would exacerbate slope instabilities outside the natural range that is found in the analysis area.

Classified System Road Conversion to OHV Trail or Mixed Vehicle Use Trail:

Under Alternative 1, approximately 4.6 miles of classified system roads would be changed to OHV or mixed vehicle use within the Forest Service system of trails in the Action Area. These trails would be converted from existing roads located on estimated risk rating of low to moderate, except where the existing template crosses drainages. These crossings are rated as high or very high estimated risk. However, project design standards developed for the Shasta Agness project area, including applicable best management practices (BMPs) such as operating under dry soil moisture conditions and application of stabilization techniques during trail reconstruction, of the National Core BMP Technical Guide (USFS 2012) would prevent risk of future failures. Examples of stabilization techniques include water bars, check dams, waddles, fill and culvert removal, and planting and seeding.

Recreation Facility Decommissioning, Maintenance, and Improvements:

Under Alternative 1 proposed project activities include approximately: 10 acres of campground decommissioning, 4 acres of campground maintenance, and 1 acre of campground improvements. Slope stability would not be an issue during project activities as these areas tend to be located on flat, gentle topography outside of steep inner gorges. In addition, slope and soil stability risk modeling indicated these areas as having low susceptibility for instability. Implementation of project design standards developed for the Shasta Agness project area, including applicable best management practices (BMPs) in the National Core BMP Technical Guide (USFS 2012) would prevent risk of potential failures if evidence is found at project site scale locations.

Alternative 1- Soil Productivity

Soil productivity can be impacted by management activities, through actions that reduce effective ground cover, displace soil, cause soil compaction or otherwise adversely impact soil structure, destabilize slopes, and change soil water and nutrient cycling processes through vegetation and down wood manipulation. Specific activities as related to the Shasta Agness project include classified road reconstruction, temporary road construction and decommissioning, silviculture treatments, fuels treatments, use of heavy equipment logging systems, instream large wood placement, campground construction and decommissioning, conversion of classified road to OHV trail, new trail construction, and trail decommissioning.

The Siskiyou National Forest Plan standards and guidelines for the soil resource require that no more than 15% of an activity area, including roads and landings, be left with detrimental soil conditions, as well as specific effective ground cover requirements to prevent erosion from mineral soil exposure (refer to *Management Direction* in this report). Project design criteria and mitigation measures have been developed specifically for the Shasta Agness Project to meet these standard and guidelines with implementation of all proposed project activities for all action alternatives.

Silvicultural

The silvicultural treatments being proposed include:

- **Oak Treatments:** Variable density treatments within oak stands including: expanding oak savannah openings, radial release around white oak, black oak and ponderosa pine, thinning to reduce stand density, skips, and planting.
- **Pine Treatments:** Variable density treatments within pine stands including: expanding serpentine pine savannah openings, radial release around Jeffrey pine, sugar pine, and western white pine, thinning to reduce stand density, creation of gaps, and skips.
- **Plantations:** Variable density treatments within plantations including: thinning to reduce stand density, radial release around species of emphasis, creation of gaps, and skips.
- **Port Orford Cedar Sanitation:** Treatments would not result in stand canopy cover being reduced below 50% in riparian reserves, below 60% in NSO nesting-roosting-foraging habitat, or below 40% in NSO dispersal habitat.
- **Riparian Reserve Thinning:** Treatments includes: fuel reduction work such as, piling and burning, lop and scatter, and prescribed fire. Thinning and cutting of understory within the primary shade zone, but wood would be felled and left; within the riparian reserve treatment zone commercial harvesting treatments would reduce canopy cover to a minimum of 50%.

Since all of the silvicultural treatments (commercial and non-commercial) maintain a component of the original forest system, including some overstory vegetation and the forest floor organic litter layer, no measurable direct or indirect adverse effects to soil productivity as it relates to nutrient cycling from these silvicultural treatments are expected. For the same reasons, no measurable direct or indirect effect to fog inputs or how precipitation is intercepted, retained, and redistributed by the tree canopy to the forest soil is expected, since measurable effects are generally only seen with more extensive vegetation removal associated with activities such as clearcutting.

Refer to Table 12 to review the dominant soil water holding capabilities of treatments within Alt. 1. Figure 17 includes this same information for Alternative 1. Slopes dominated by low and very

low water holding capacities may not be resilient over time due to competition for limited soil water that becomes more important during drought periods. By contrast, high areas are more resilient.

Harvest Logging Systems

Table 15, below, provides an estimate of the worst case scenario amount of detrimental disturbance that could potentially occur with each harvest system, per Action Alternative. However, implementation of Project Design Criteria and Mitigation Measures (DEIS Appendix B), such as limiting use of vehicles and equipment to dry soil conditions, designating skidtrails before implementation, or use of slash mats, is expected to result in less than the estimated acreages actually resulting in *detrimental* disturbance (in particular displacement and compaction), since these measures are designed to limit or reduce the overall impacts of the actions to prevent the creation of a *detrimental* condition. In addition, during implementation, pre-existing (legacy) skid trails and landings shall be re-used to the extent practicable; so as to minimize additional ground impacts (i.e. new detrimental soil conditions).

The detrimental soil conditions Standards and Guidelines are the same across all management areas and land allocations, and therefore no distinction between land allocations is made in estimating the acres of detrimental disturbance. Additional Project Design Criteria related to activities in Riparian Reserves, for example, within 100 feet of stream courses, limit detrimental disturbance adversely affecting soil infiltration capacity (i.e., detrimental compaction) to 10 percent, would result in even less total area experiencing detrimental disturbance from project activities.

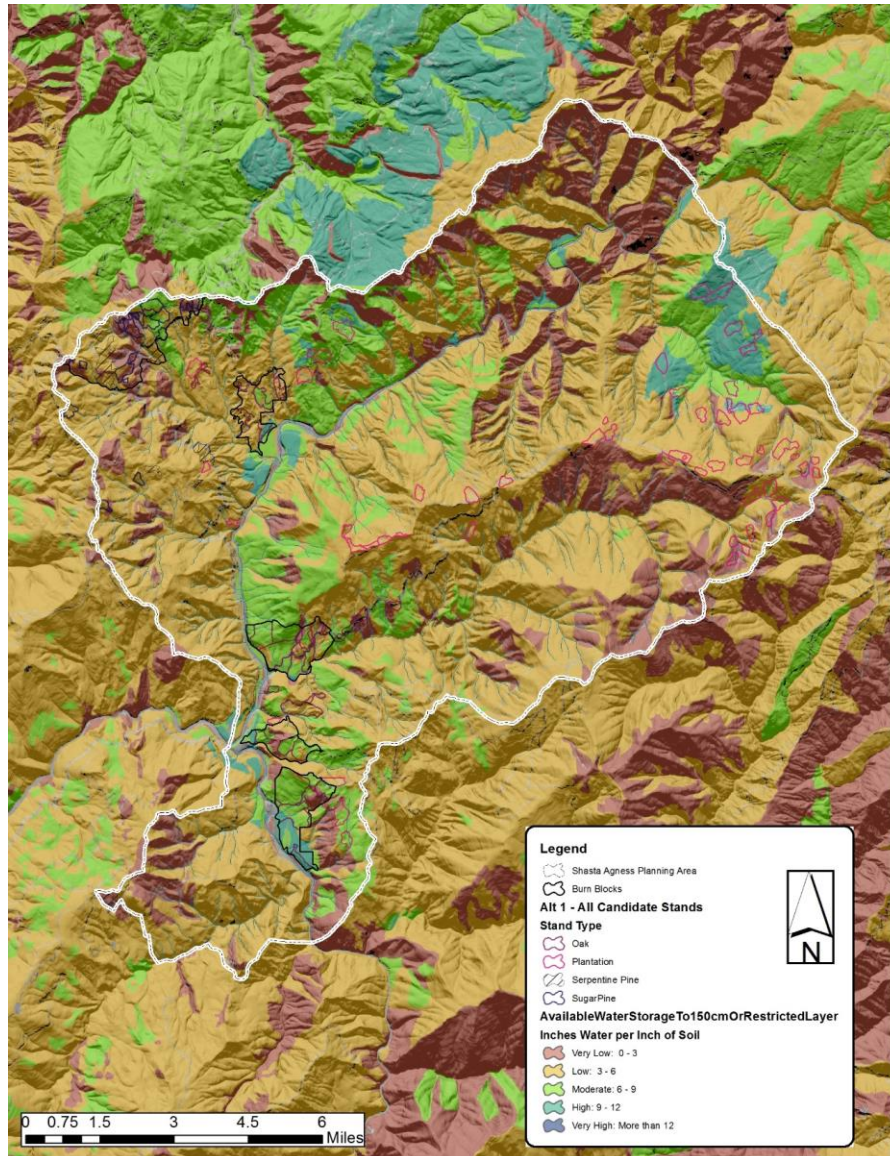
The total amount of detrimental disturbance for helicopter landings was less than one acre for each alternative, therefore when rounding to the nearest whole number the estimated acres of detrimental disturbance was zero. Helicopter landings range from 4.95 acres to 6.75 acres between alternatives 1, 2, and 3.

Table 15. Estimated Acres of logging systems-related detrimental disturbance per action alternative

	Alternative 1	Alternative 2	Alternative 3
Ground-based harvest system (est. 15%)	203 acres	182 acres	156 acres
Skyline harvest system (est. 5%)	74 acres	59 acres	47 acres
Aerial (helicopter) harvest system (est. 2%)	19 acres	17 acres	15 acres
Pile and Burn ¹⁴ (est. 2%)	37 acres	17 acres	0 acres
Totals	333 acres	275 acres	218 acres

¹⁴ Including Riparian Reserves, where some acres would include piling and burning, and potential for pile and burning in non-commercial treatment units.

Figure 17. Available water storage of candidate stands in alternative 1 within Shasta Agness planning area.



Temporary Roads and Landings

See discussion under (F) Roads- Temporary roads and Landings for a description of the effects from temporary roads on soil productivity. Approximately 25 acres of the Shasta Agness planning

area would have a reduction in soil productivity from 17 miles of temporary road construction, however soil restoration practices and their temporary use would allow productivity to be rehabilitated to the highest degree possible following operations. In addition, because a portion of these roads are currently existing templates from historical management uses, active restoration would expedite the recovery of soil productivity to the compacted surfaces improving the existing conditions for soil productivity.

Activity Fuel Treatments and Adaptive Fire Re-entry:

Project Design Criteria and Mitigation Measures that have been designed for the Shasta Agness Project, including applicable best management practices (BMPs) in the National Core BMP Technical Guide (USFS 2012) and the Region 6 General Water Quality Best Management Practices (USFS 1988), as well as Regional and Forest level Standards and Guidelines, have influenced the planning of fuels treatment activities during project development, and would be implemented to minimize impacts of fuels treatments on soil productivity. Examples include: planning pile burning when litter, duff, and soil moistures are high, minimizing the size of piles, and implementing erosion control measures before extended periods of wet weather. Therefore, the effects from fuel treatments on soil productivity are expected to be within the range of natural variability for fire effects to soils, including changes to soil structure (particularly as a result of loss of organic matter), changes in porosity and bulk density, loss of cover (i.e., canopy, litter, duff), water repellency, and runoff and erosion vulnerability.

Instream Large Wood Placement:

It is not expected instream large wood placement on approximately 29 miles of streams would have an effect on soil productivity. Project design criteria and mitigation measures have been developed to prevent concerns with soil productivity such as stockpiling and protecting topsoil, contouring of site, and revegetating site following operations. Revegetation of upland riparian sites have beneficial effects to long-term soil productivity, prevention of erosion and sedimentation, supplementation of large woody debris over time, and slope stability, directly through planting, seeding, and mulching of sites, and indirectly over time with contributions to litter, root structure, and nutrient enhancement.

Trail Decommissioning and Conversion of Road System to OHV Use:

Alternative 1 proposes to change 4.6 miles of classified system road to OHV trails. According to the study, *Effects of All-Terrain Vehicles on Forested Lands and Grasslands*, ATV activities adversely affect soils. However, through proper trail design, maintenance, and the use of PDCs and BMPs the study suggests these would be effective tools for keeping natural resources in balance (USDA 2008). Roads currently at ML 1 have allowed passive restoration to occur, and as such would see hindrances in their soil characteristics due to the conversion from road storage to trail use for road 3577350 and spur. Maintenance level 2 systems roads are currently open to vehicle use, and soil productivity has been considered a long-term commitment to something other than production of forest vegetation. Alternative 1 would close and rehabilitate the Nancy Creek Trail 1181, approximately 1.9 miles of trail, in the project area. Rehabilitation would restore surface organics to exposed soils and stabilize eroding soils on the 1.9 miles of trail tread, which overlays soils with severe erosion potential. Site productivity would improve and become restored over time as litter and vegetation reclaim the disturbed areas. No new trails are proposed in Alternative 1.

Recreation Facility Decommissioning, Maintenance, and Improvements:

Under Alternative 1 approximately 10 acres of campground facilities would be closed and rehabilitated; approximately 4 acres of facility maintenance would be completed, and an estimated 1 acre of improvements to Foster Bar boat launch and Upper Rogue trailhead would be accomplished. Maintenance includes: the potential to implement off highway vehicle mitigation, signage, invasive removal, trail and/or trailhead maintenance, and resource damage repairs. Decommissioning of campgrounds would have short term effects to soil during reclamation. Short term effects consist of: localized erosion and impacts to soil structure from heavy equipment use. However, the restoration of surface organics, and breaking up compaction layers to improve infiltration rates would improve the soil productivity at these sites for the long term. Maintenance and improvements to the facilities would not affect soil productivity. Boat launch improvements would take place on riverwash, which does not affect soil productivity. In addition, all activities would implement design features developed specifically for the Shasta Agness project areas to prevent potential effects to the soil resource.

2. Alternative 2 (Modified Collaborative Alternative)

Unique Landscape Vegetation Treatments

Alternative 2 would treat an estimated 4,685 acres for proposed silvicultural activities, including fuel treatments. These harvest treatments would include 3,228 acres of commercial thinning and 1457 acres of non-commercial thinning. The following describes the estimated total acreage for each logging system: 1,211 acres with tractor systems, 1,177 acres with skyline systems, and 840 acres by helicopter. This includes all of the primary management objectives (develop and enhance late seral habitat (DELSH), restore oak communities, and restore riparian reserves). Treatments would involve multiple silvicultural prescriptions, including variable density thinning, hardwood retention, and 1 acre maximum patch cuts. Variable density thinning would be limited to a minimum canopy cover of 40%, except where white oak-savannah restoration and release are the main objectives. Target canopy cover for white oak restoration ranges from 0-20%; oak savannah release treatments, which are defined by cutting all Douglas-Fir within 50 feet of oak-savannah, would maintain a canopy cover of 20-40%. Fuels treatments would involve pruning, piling, and burning post vegetation treatment, with underburning 1 to 5 years post treatment. Treatment methods would involve a combination of manual (hand) work, and mechanized equipment including ground-based, cable-yarding, and helicopter equipment. It is estimated that approximately 14 miles of temporary roads would be needed to provide temporary access to meet project objectives.

Aquatic and Riparian Habitat Treatments

Desired conditions for riparian areas are described under Alternative 1. Alternative 2 would treat approximately 1,048 acres within Riparian Reserves for all proposed silvicultural thinning. These harvest treatments would include 475 acres of commercial thinning and 578 acres of non-commercial thinning. The following describes the estimated total acreage for each logging system: 271 acres with tractor systems, 149 with skyline systems, and 195 acres by helicopter. Approximately, 0.7 miles of existing temporary roads is needed within riparian reserves to achieve desired conditions of riparian areas.

See Alternative 1 for proposed instream large wood placement and aquatic passage removal for Shasta Agness project activities.

Sustainable Roads

Alternative 2 road treatments are discussed above in the *Direct and Indirect Effects Common to All Action Alternatives*. Estimated soil disturbance is described in Table 2 and Table 13. Table 2 approximates miles proposed for road decommissioning, storage (ML2 to ML1), road openings (ML1 to ML2), haul routes, and new and non-system road template construction. Table 13 describes the current ML, ML recommendation for each alternative, and the estimate acreage impacted by each alternative.

Sustainable Recreation

Alternative 2 recreation proposed treatments are described in Table 4 and Table 5, below the *Introduction* (estimated in miles and acres).

Alternative 2- Soil Stability

Figure 18, Figure 19, and Figure 20 display the slope stability and soil erosion risk mapping within the Alternative 2 proposed treatment units, proposed road use changes, and new trail construction.

Silvicultural and Harvest Logging Systems:

Silvicultural treatments and harvest logging operations proposed in Alternative 2 would have the same effects on slope stability as described in Alternative 1, only over less acres since pine units are not included. There is a difference of 2,282 fewer acres compared with Alternative 1. Based on the silvicultural treatments proposed, it is not expected that there would be a measurable effect that would result in an increase in slope failures in the project area. In addition, refer to Table 9 for an estimate of potential detrimental disturbance within stands proposed for Alternative 2.

Temporary Roads and Landings:

Activities proposed in Alternative 2 are expected to need 14 miles of temporary roads in order to achieve management objectives. This is 3 miles less than Alternative 1. Approximately 10 miles are expected to re-use existing legacy templates from past management. An estimated of 4 miles are proposed new temporary roads. Project Design Criteria and Mitigation Measures that have been designed for the Shasta Agness project, including best management practices (BMPs) for temporary and classified road activities in the National Core BMP Technical Guide (USFS 2012) and the Region 6 General Water Quality Best Management Practices (USFS 1988), have influenced the planning of road activities during project development, and would be implemented to minimize impacts of temporary roads on slope stability.

Activity Fuel Treatments and Adaptive Fire Re-entry:

Fuels treatments proposed in Alternative 2 would have the same effects on slope stability as described in Alternative 1, only over less acres. There is a difference of 2,041 fewer acres of activity fuels treatments and adaptive fire re-entry between Alternative 1 and Alternative 2 (see Table 1). Based on the fuels treatments proposed, it is not expected that there would be a measurable effect from fuels treatments that would result in an increase in slope failures in the project area.

Instream Large Wood Placement:

Instream large wood placement would have the same effects on slope stability as described in Alternative 1. Proposed treatment areas do not change between alternatives.

New Trail Construction and Change to OHV Trails:

Alternative 2 proposes 9.4 additional miles of new trail construction in the Shasta Agness planning area compared to alternative 1. The proposed trail system would have an effect on soil productivity through increased likelihood of surface erosion, as well as a commitment of the soil resource to something other than supporting a forest ecosystem. The nature of effects of the change in classified road system to OHV trail use would have the same effect as described in Alternative 1 though at a higher degree due to the increase of miles. The effects of constructing new trails within the planning area are described under *Sustainable Recreation*. Project design features would prevent the destabilization of slopes from trail development because additional consultation by a geologist or soil scientist would be completed during trail design and layout to adjust design if the potential of risk failures exist. Current slope stability and soil erosion risk hazard has generally mapped these areas as low, except where trails cross streams.

Recreation Campground Developments:

Alternative 2 proposes 51.5 acres of proposed campground developments. Slope stability would not be an issue because proposed locations are on gentle topography on flats and outside and above the steeper canyon walls within the planning area. In addition, during the construction of these recreational facilities project design criteria (see DEIS Appendix B) would be followed to avoid areas of instability.

Figure 18. Slope stability and soil erosion risk map of the West portion of the planning area, with Alternative 2 units, road proposals, and new trail construction.

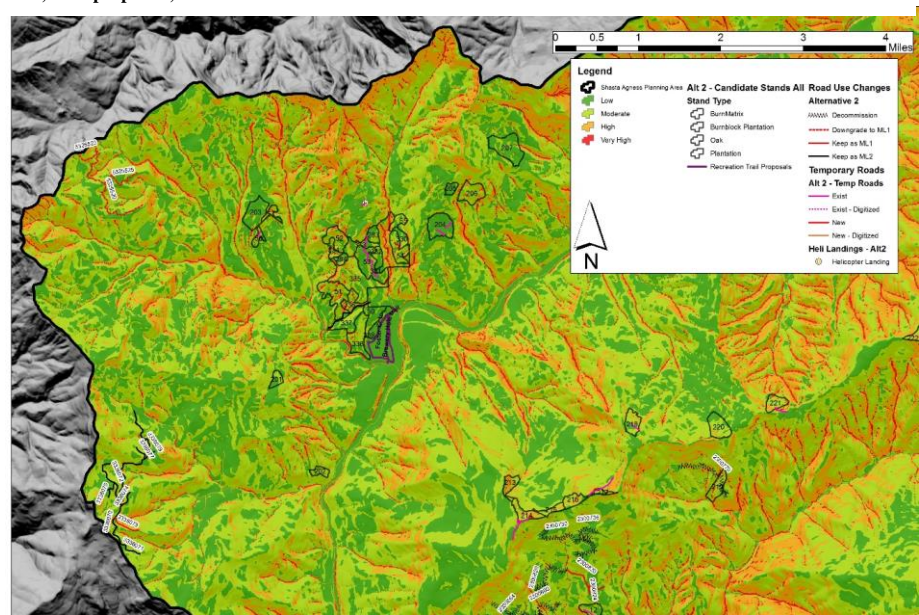


Figure 19. Slope stability and soil erosion risk map of the East portion of the planning area, with Alternative 2 units, road proposals, and new trail construction.

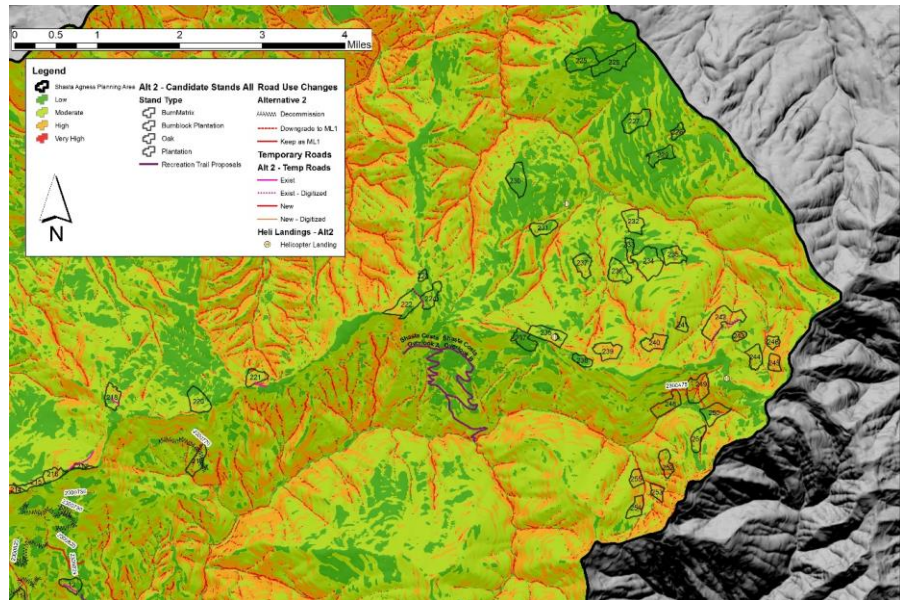
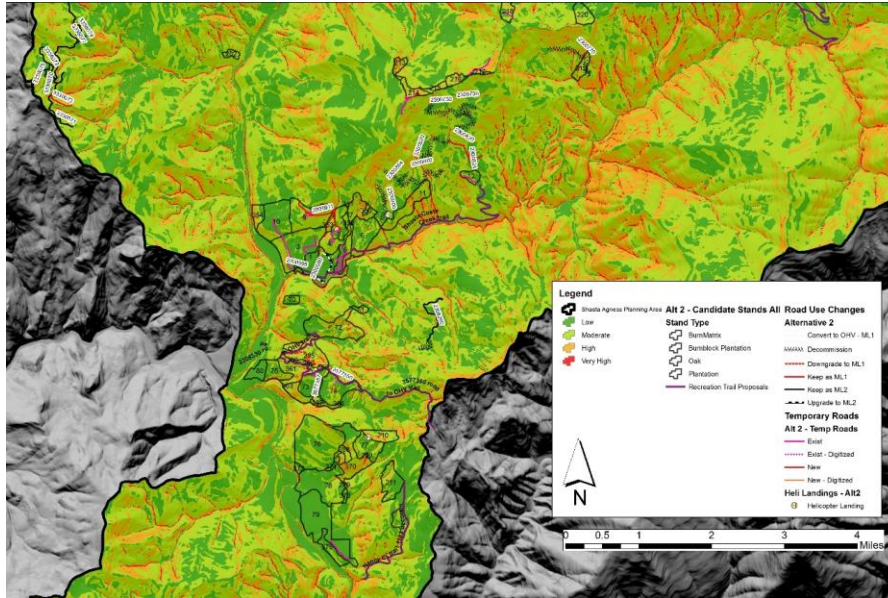


Figure 20. Slope stability and soil erosion risk map of the South portion of the planning area, with Alternative 2 units, road proposals, and new trail construction.



Alternative 2- Soil Productivity

The effects in Alternative 2 to soil productivity are similar to what is described under Alternative 1. Alternative 2 proposes less acres, and therefore impacts to soil productivity would be less than in Alternative 1. Silvicultural treatments propose no treatment on pine stands, which decreases the impacts from silvicultural, harvest logging systems, temporary roads and landings, and activity fuels treatment to the project area. However, for aquatic and riparian habitat improvements effects would remain the same as the proposed acres do not change between alternatives. Project activities that differ in Alternative 2, which effect soil productivity, focus mainly on recreation improvements.

Silvicultural:

No measureable effects of silvicultural treatments are expected for Alternative 2 for the reasons described under Alternative 1.

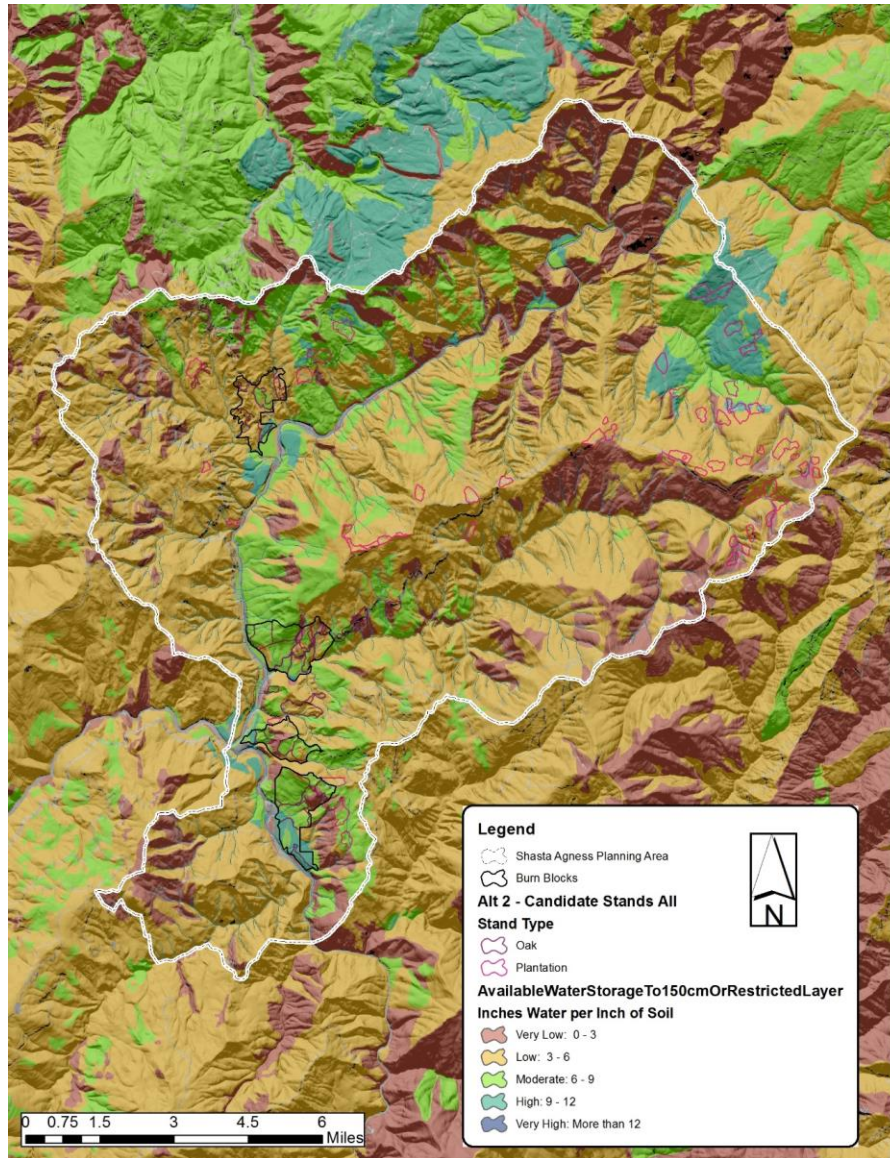
Slopes dominated by low and very low water holding capacities may not be resilient over time due to competition for limited soil water that becomes more important during drought periods. By contrast, high areas are more resilient. Figure 21 displays the water holding capacity of soils with the Alternative 2 treatment units. Table 12 lists each of the treatment units, the primary objective of each unit, and the inherent water holding capacities of the soils within those units. Alternative 2 would not treat pine units or port-orford cedar sanitation zones, therefore silvicultural practices would not affect these areas.

With Alternative 2, proper effective ground cover following operations would be implemented to protect soils from excessive erosion.

Harvest Logging Systems:

Effects of harvest systems, including ground-based, skyline-cable, aerial, and ground-based on steeper slopes, would be the same as those described under Alternative 1, only there would be less effects since less acres are included for treatments in Alternative 2.

Figure 21. Available water storage of candidate stands in alternative 2 within Shasta Agness planning area.



Temporary Roads and Landings

Effects of temporary roads and landings would be the same as those described under Alternative 1, only there would be less effects since there would be 3 miles less needed for treatments in Alternative 2.

Activity Fuel Treatments and Adaptive Fire Re-entry

Effects of activity fuel treatments and adaptive re-entry would be the same as those described under Alternative 1, only there would be less effects since there is a difference of 2,041 acres between Alternative 1 and Alternative 2.

Instream Large Wood Placement

Alternative 2 does not change from Alternative 1. No measureable effects of soil productivity are expected in Alternative 2. See Alternative 1 for further information.

New Trail Construction and Road System Conversion to OHV Trails

Under Alternative 2, approximately three additional acres of new trails would be added to the Forest Service system trails in the project area, excluding the conversion of road system to OHV trails. Alternative 1 discusses the effects of road system conversion to OHV trails, and therefore will not be discussed further in this alternative. Refer to Alternative 1- *Trail Decommissioning and Conversion of Road System to OHV Use*, above.

Trail names and lengths are described under *Introduction* in Table 5. Trails would be constructed with standards and design criteria that minimize or prevent erosion, and by design minimize or prevent the development of trail widening and braiding over time. The entire authorized trail system in the project area would result in a commitment of approximately 3 additional acres of soils directly to trail tread. Due to the narrow (average 2 to 3 foot width), and linear nature of this soil commitment, however, the impact at any point on the landscape is not large enough to cause detrimental impacts to soil productivity in adjacent soils and vegetation. The impacts of the trail tread on soil structure, organic matter, or exposed soils are not spatially large enough or deep enough into the soil profile, to impact development of tree roots under trail tread, or reduce the productivity of vegetation adjacent to the trails.

Table 16 displays the authorized trail system that would exist in the project area with implementation of Alternative 2. Seventy-six percent of the trail system would be on soils with severe erosion potential, however, sustainably constructed trails in the project area would be expected to not develop excessive surface soil erosion over the long term and would not result in detrimental effects to soil productivity, with the exception of 3 acres that would be taken out of soil productivity. Eight percent of the trail system would be on soils with moderate erosion potential, and sixteen percent would be on soils with slight erosion potential.

Table 16. Alternative 2 proposed recreation trail effects on soil characteristics describing the erosion hazard of each soil map unit of project area.

Name Recreation Trail	Map Unit	Map Unit Name	Erosion hazard (Road and Trail)
Big Bend Battlefield trail	1. 61A 2. 1D	1. Clawson sandy loam, 0 to 3 percent slopes 2. Abegg gravelly loam, 7 to 20 percent slopes	1. Slight 2. Moderate
Foster Cr to Brewery Hole trail	3. 57A 4. 61A 5. 257A	3. Central Point sandy loam, 0 to 3 percent slopes 4. Clawson sandy loam, 0 to 3 percent slopes 5. Takilma cobbly loam, 0 to 3 percent slopes	3. Severe 4. Slight 5. Slight
Foster/Brewery tie-in w/Up. Rogue trail	6. 61A 7. 257A	6. Clawson sandy loam, 0 to 3 percent slopes 7. Takilma cobbly loam, 0 to 3 percent slopes	6. Slight 7. Slight
FSR 2308330 to OHV trail	8. 13G 9. 267F 10. 158F	8. Atring-Vermisa complex, 60 to 90 percent north slopes 9. Vermisa Beekman-Colestine complex, 30 to 60 percent south slopes 10. Kanid-Acker-Atring complex, 30 to 60 percent north slopes	8. Severe 9. Severe 10. Severe
FSR 3577350 to OHV trail	11. 13G 12. 159F 13. 233F 14. 25G 15. 197E 16. 9G	11. Atring-Vermisa complex, 60 to 90 Percent north slopes 12. Kanid-Acker-Atring complex, 30 to 60 percent south slopes 13. Shastacosta-Pollard-Beekman complex, 30 to 60 percent south slopes 14. Beekman-Vermisa complex, 60 to 90 percent south slopes 15. Pollard-Josephine-Shastacosta complex, 2 to 30 percent slopes 16. Atring-Kanid-Vermisa complex, 60 to 90 percent south slopes	11. Severe 12. Severe 13. Severe 14. Severe 15. Severe 16. Severe
Nancy Cr trail 1181 decommissioned	17. 233F 18. 189G 19. 13G 20. 99E	17. Shastacosta-Pollard-Beekman complex, 30 to 60 percent south slopes	17. Severe 18. Severe 19. Severe 20. Severe

		18. Pearsoll-Gravecreek-Rock outcrop complex, 60 to 90 percent south slopes 19. Atring-Vermisa complex, 60 to 90 percent north slopes 20. Dumont-Acker-Kanid complex, 0 to 30 percent slopes	
Shasta Costa Creek trail	21. 233F 22. 189G 23. 61A 24. 13G 25. 131G 26. 267F 27. 105F 28. 197E 29. 94F	21. Shastacosta-Pollard-Beekman complex, 30 to 60 percent south slopes 22. Pearsoll-Gravecreek-Rock outcrop complex, 60 to 90 percent south slopes 23. Clawson sandy loam, 0 to 3 percent slopes 24. Atring-Vermisa complex, 60 to 90 percent north slopes 25. Gravecreek-Eightlar-Pearsoll complex, 60 to 90 percent north slopes 26. Vermisa-Beekman-Coolestine complex, 30 to 60 percent south slopes 27. Eightlar-Gravecreek-Pearsoll complex, 30 to 60 percent north slopes 28. Pollard-Josephine-Shastacosta complex, 2 to 30 percent slopes 29. Dubakella-Cornutt-Pearsoll complex, 20 to 60 percent south slopes	21. Severe 22. Severe 23. Slight 24. Severe 25. Severe 26. Severe 27. Severe 28. Severe 29. Severe
Shasta Costa Overlook A	30. 9F 31. 155F 32. 20E 33. 12G 34. 11F 35. 160G	30. Atring-Kanid-Vermisa complex, 30 to 60 percent south slopes 31. Jayar-Rock outcrop-Althouse complex, 30 to 60 percent south slopes 32. Bearcamp-Brandypeak complex, 0 to 30 percent slopes 33. Atring-Rock outcrop-Vermisa complex, 60	30. Severe 31. Severe 32. Moderate 33. Severe 34. Severe 35. Severe

		to 90 percent south slopes 34. Atring-Rock outcrop-Kanid complex, 30 to 60 percent south slopes 35. Kanid-Atring complex, 60 to 90 percent north slopes	
Shasta Costa Overlook B	36. 20E 37. 11F	36. Bearcamp-Brandypeak complex, 0 to 30 percent slopes 37. Atring-Rock outcrop-Kanid complex, 30 to 60 percent south slopes	36. Moderate 37. Severe

Recreation Campground Developments

Under Alternative 2 there would be a direct effect to approximately 47 acres of land being taken out of soil productivity, in comparison to Alternative 1, through new campground construction, reopening, and new campground improvements such as a host and trailhead horse camp facilities. These activities would cause soil compaction, displacement, and short term soil erosion during construction. Minor improvements and campground maintenance including: off highway vehicle mitigation, signage, invasive removal, trail and/or trailhead maintenance, and resource damage repairs would occur on approximately 4 acres of land. The estimated total footprint of campgrounds and trails would dedicate its purpose to recreation instead of supporting forest vegetation. These developments and maintenance activities would result in a minor loss of some soil productivity and minimal local effects to soil quality during implementation. Revegetation and rehabilitation in areas with unauthorized OHV damages also might improve local soil conditions, including productivity and stability within repaired areas.

Unique Landscape Vegetation Treatments

Alternative 3 would treat an estimated 3796 acres for proposed silvicultural activities, including fuel treatments. In addition, 241 acres of Port Orford Cedar (POC) sanitation would be implemented in high risk areas to a diameter limit of 12 inches. High risk areas are low-lying wet areas (infested or not) that are located downslope from already infested areas or below likely sites for future introductions, especially roads and streams, are high-risk sites. These harvest treatments would include 2,708 acres of commercial thinning and 1,088 acres of non-commercial thinning. The following describes the estimated total acreage for each logging system: 1,041 acres with tractor systems, 929 acres with skyline systems, and 738 acres by helicopter. This includes all of the primary management objectives (develop and enhance late seral habitat (DELSH), restore oak communities, and restore riparian reserves). Treatments would involve multiple silvicultural prescriptions, including variable density thinning, hardwood retention, and 1 acre maximum patch cuts. Variable density thinning would be limited to a minimum canopy cover of 40%, except where white oak-savannah restoration and release are the main objectives. Target canopy cover for white oak restoration ranges from 0-20%; oak savannah release treatments, which are defined by cutting all Douglas-Fir within 50 feet of oak-savannah, will maintain a canopy cover of 20-40%. Fuels treatments would involve pruning and piling & burning of machine and/or handpiles. Treatment methods would involve a combination of manual (hand) work, and mechanized equipment including ground-based, cable-yarding, and

helicopter equipment. It is estimated that approximately 14 miles of temporary roads would be needed to provide temporary access to meet project objectives.

Aquatic and Riparian Habitat Treatments

Desired conditions for riparian areas are described under Alternative 1. Alternative 3 would treat approximately 748 acres within Riparian Reserves for all proposed silvicultural thinning. These harvest treatments would include 343 acres of commercial thinning and 405 acres of non-commercial thinning. The following describes the estimated total acreage for each logging system: 187 acres with tractor systems, 119 acres with skyline systems, and 112 acres by helicopter. Approximately, 0.7 miles of existing temporary roads is needed within riparian reserves to achieve desired conditions of riparian areas.

See Alternative 1 for proposed instream large wood placement and aquatic passage removal for Shasta Agness project activities.

Sustainable Roads

Alternative 3 road treatments are discussed above in the *Direct and Indirect Effects Common to All Action Alternatives*. Estimated soil disturbance is described in Table 2 and Table 13Table 12. Table 2approximates miles proposed for road decommissioning, storage (ML2 to ML1), road openings (ML1 to ML2), haul routes, and new and existing temporary road construction. Table 13describes the current ML, ML recommendation for each alternative, and the estimate acreage impacted by each alternative.

Sustainable Recreation

Alternative 3 recreation proposed treatments (estimated by are described in Table 4 and Table 5, below the *Introduction* (estimated in miles and acres).

3. Alternative 3 (Minimum Scope)

Alternative 3- Slope Stability

Figure 22, Figure 23, and Figure 24 display the slope stability and soil erosion risk mapping within the Alternative 3 proposed treatment units, proposed road use changes, and temporary roads.

Silviculture and Harvest Logging Systems

Silvicultural treatments and harvest logging operations proposed in Alternative 3 would have the same effects on slope stability as described in Alternative 1, only over less acres since unroaded areas and additional burn block are removed from treatment areas. There is a difference of 2,282 acres compared with Alternative 1. Based on the silvicultural treatments proposed, it is not expected that there would be a measurable effect that would result in an increase in slope failures in the project area. In addition, refer to Table 9 for an estimate of potential detrimental disturbance within stands proposed for Alternative 3.

Temporary Roads and Landings

Activities proposed in Alternative 3 are expected to need 12 miles of non-system road templates in order to achieve management objectives. This is 5 miles less than Alternative 1 since new temporary roads are not proposed. Project Design Criteria and Mitigation Measures that have

been designed for the Shasta Agness project, including best management practices (BMPs) for temporary and classified road activities in the National Core BMP Technical Guide (USFS 2012) and the Region 6 General Water Quality Best Management Practices (USFS 1988), have influenced the planning of road activities during project development, and would be implemented to minimize impacts of temporary roads on slope stability.

Activity Fuel Treatments and Adaptive Re-entry

Fuels treatments proposed in Alternative 3 would have the same effects on slope stability as described in Alternative 1, only over less acres. There is a difference of 2, 929 acres of activity fuels treatments and adaptive fire re-entry between Alternative 1 and Alternative 3 (see Table 1). Based on the fuels treatments proposed, it is not expected that there would be a measurable effect from fuels treatments that would result in an increase in slope failures in the project area.

Instream Large Wood Placement

Instream large wood placement would have the same effects on slope stability as described in Alternative 1. Proposed treatment areas do not change between alternatives.

Campground and Trail Decommissioning and Facility Maintenance

Under Alternative 3 there is proposed trail decommissioning of the Nancy Creek Trail 1181, approximately 1.9 miles; Billings Creek dispersed campground decommissioning of 0.2 acres; and an estimated of 4 acres of maintenance/improvements at Foster Bar, Shasta Costa, and Oak Flat recreational facilities. These activities would have the same effects as Alternative 1, only a difference of 0.5 acres less than Alternative 1. Alternative 3 does not include improvements to Upper Rogue trailhead or to Foster Bar boat launch site.

Figure 22. Slope stability and soil erosion risk map of the East portion of the planning area, with Alternative 3 units and road proposals.

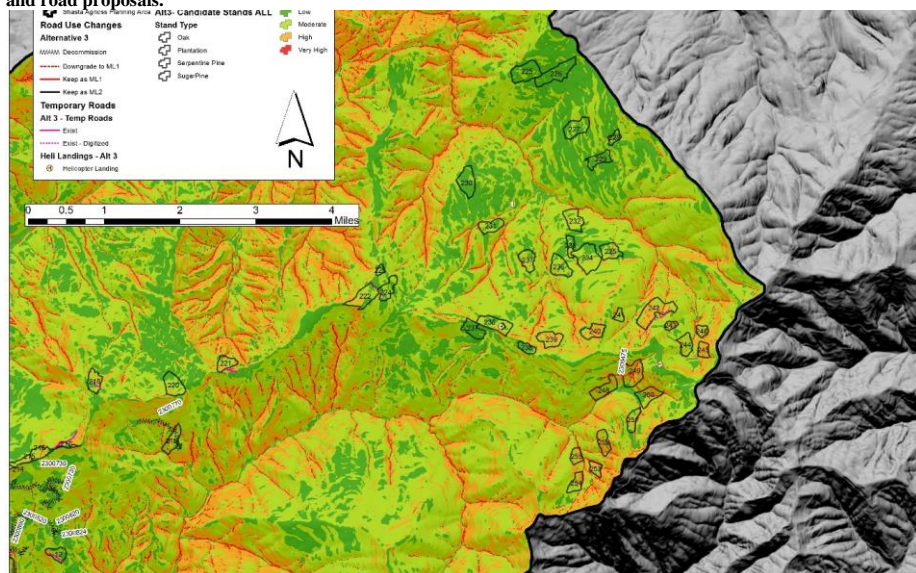


Figure 24. Slope stability and soil erosion risk map of the South portion of the planning area, with Alternative 3 units and road proposals.

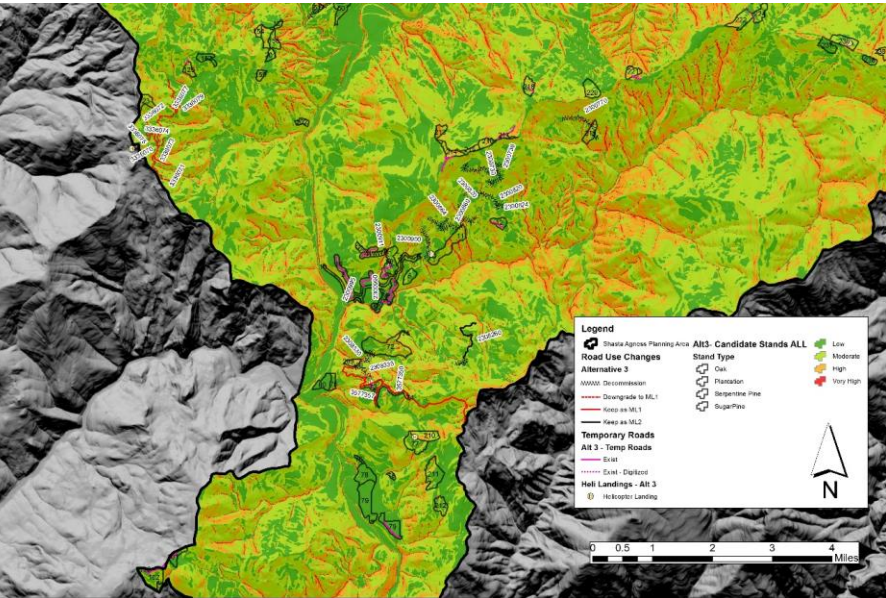
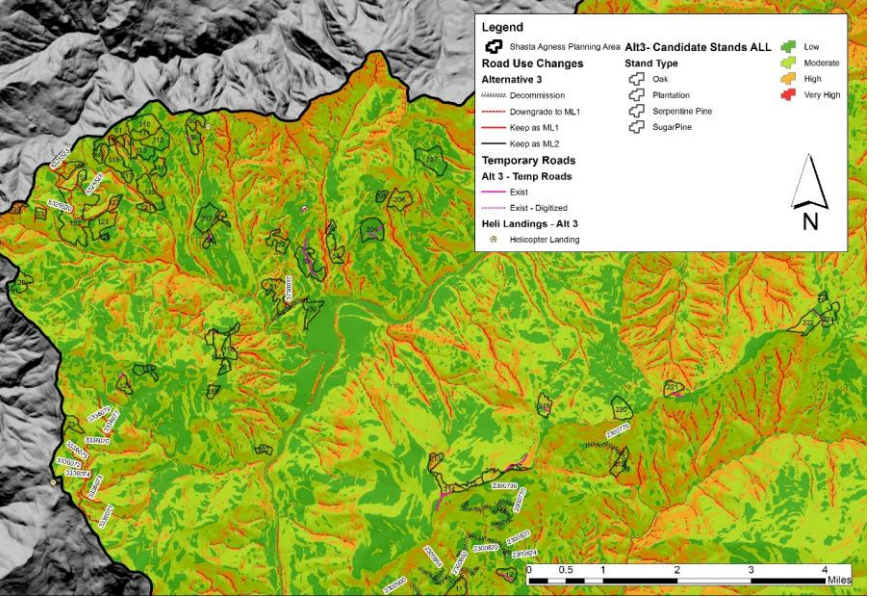


Figure 23. Slope stability and soil erosion risk map of the West portion of the planning area, with Alternative 3 units and road proposals.



Alternative 3- Soil Productivity

Soil productivity can be impacted by management activities, through actions that reduce effective ground cover, displace soil, cause soil compaction or otherwise adversely impact soil structure, destabilize slopes, and change soil water and nutrient cycling processes through vegetation and down wood manipulation

The Siskiyou National Forest Plan standards and guidelines for the soil resource require that no more than 15% of an activity area, including roads and landings, be left with detrimental soil conditions, as well as specific effective ground cover requirements to prevent erosion from mineral soil exposure (refer to Management Direction in this report). Project design criteria and mitigation measures have been developed specifically for the Shasta Agness project to meet these standard and guidelines with implementation of all proposed project activities for all action alternatives.

The effects in Alternative 3 to soil productivity are similar to what is described under Alternative 1. Alternative 3 proposes less acres, and therefore impacts to soil productivity would be less than in Alternative 1. Silvicultural treatments propose no treatment on unroaded areas and no new construction of temporary roads, which decreases the impacts from silvicultural, harvest logging systems, temporary roads and landings, and activity fuels treatment to the project area. However, for aquatic and riparian habitat improvements, the mechanism of effects would remain the same, though the proposed acres vary slightly between alternatives 1 and 3 with the removal of the burn-between blocks. Recreation project activities are similar to what is proposed in Alternative 1.

Silvicultural:

Effects of silvicultural treatments would be the same as those described under Alternative 1, only there would be less effects since less acres are included for treatments in Alternative 3.

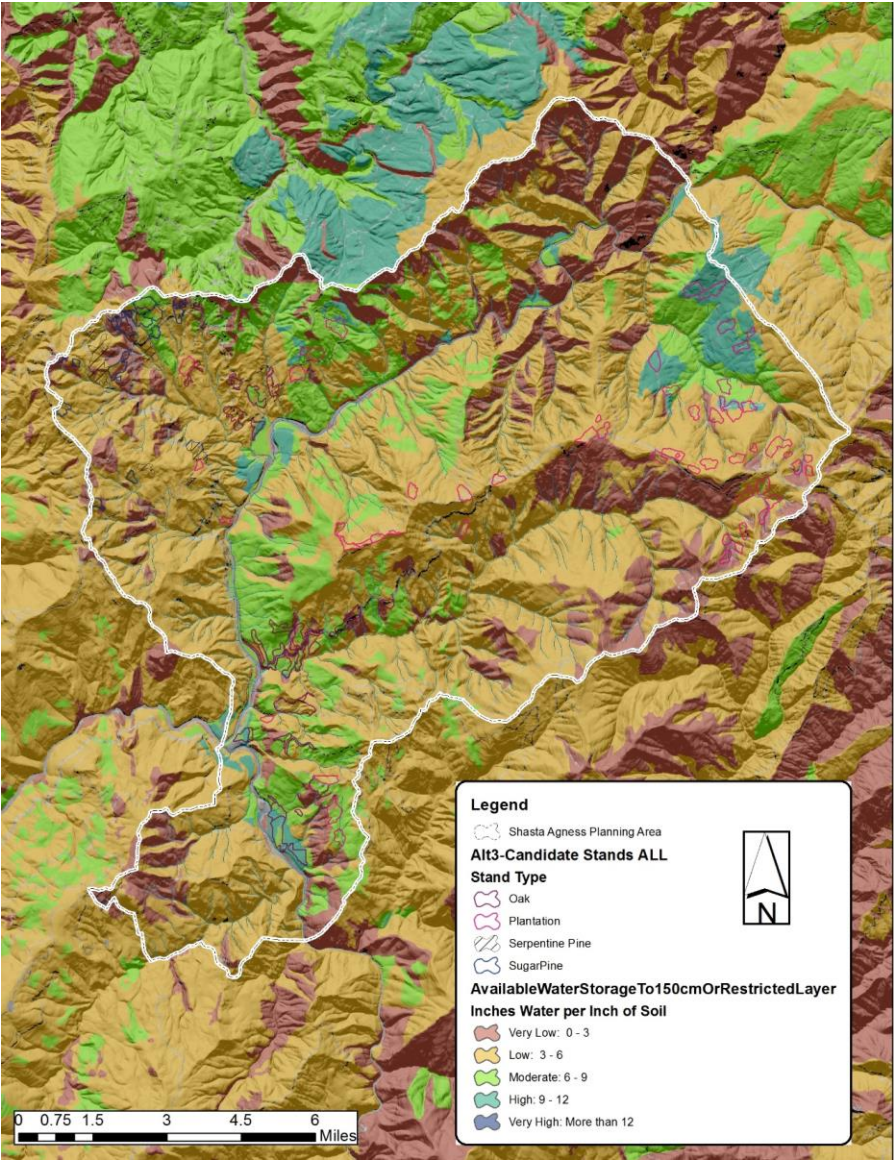
Figure 25 displays the water holding capacity of soils with the Alternative 3 treatment units. Table 12 lists each of the treatment units, the primary objective of each unit, and the inherent water holding capacities of the soils within those units. Alternative 3 would not treat unroaded areas or additional burn blocks, therefore silvicultural practices would not affect these areas.

With Alternative 3, proper effective ground cover following operations would be implemented to protect soils from excessive erosion.

Harvest Logging Systems

Effects of harvest systems, including ground-based, skyline-cable, aerial, and ground-based on steeper slopes, would be the same as those described under Alternative 1, only there would be less effects since less acres are included for treatments in Alternative 3.

Figure 25. Available water storage of candidate stands in alternative 3 within Shasta Agness planning area.



Temporary Roads and Landings

Effects of temporary roads and landings would be the same as those described under Alternative 1, only there would be less effects since there would be 5 miles less needed for treatments in Alternative 3. No new temporary road construction is proposed for Alternative 3, as the proposed 12 miles of temporary roads would be located on existing historical templates.

Activity Fuel Treatments and Adaptive Fire Re-entry

Effects of activity fuel treatments and adaptive re-entry would be the same as those described under Alternative 1, only there would be less effects since there is a difference of 2,929 acres between Alternative 1 and Alternative 3.

Instream Large Wood Placement

Alternative 3 does not change from Alternative 1. No measureable effects of soil productivity are expected in Alternative 3. See Alternative 1 for further analysis.

Recreation Trail Decommissioning:

Under Alternative 3 effects from decommissioning 1.9 miles of trail would be the same as Alternative 1. The conversion of 4.6 miles of closed road to OHV use would not occur, so the effects described in alternative 1 from that proposal would not occur.

Recreation Facility Decommissioning, Maintenance, and Improvements:

Effects from recreation projects would be nearly the same as under alternative 1. The improvements to Foster Bar boat launch and Upper Rogue trailhead would not occur, but the decrease in impacts would not be measurable.

4. Alternative 4- No- Action

Under the No-Action alternative, no proposed project activities would take place. No soils would be disturbed from vegetation or fuels management activities, aquatic and riparian habitat improvements, or recreation treatment activities. Soils would continue to develop along current trajectories and under natural vegetation and climatic conditions. Disturbed soils from past activities would continue on a passive restoration trajectory. All system and non-system roads and their existing templates currently on the landscape would remain with the same impacts to soil productivity based on use. The forest floor would remain intact, maintaining effective ground cover, though potentially at levels higher than would naturally exist with natural fire disturbance. Slope stabilities would be commensurate with natural conditions, except where instability is affected by roads, which would have the continued potential to fail if under deferred maintenance and with the right set of conditions. Inherent water holding capacities of soils would continue to influence the vigor of vegetation across the landscape, based on annual precipitation, vegetation densities due to lack of historic fire disturbance and competition for limited water. Within sites assessed, the most noted evidence of instability were landslides associated with the current road system or slump-earthflows along steep inner channels of streams such as in Billings, Shasta Costa, and Snout Creek. Without decommissioning, maintenance, storage, or reconstruction components where appropriate, failures related to existing system and non-system roads are expected to continue adding sediment to streams.

D. Cumulative Effects

Cumulative effects related to soil productivity are the incremental impacts of an alternative when added to the effects of other past, present, and reasonably foreseeable future actions. See the draft EA for a summary of all past, present, and reasonably foreseeable future actions in the project area.

The geographic scope for the cumulative effects analysis area for the soil resource includes the proposed treatment activities (silvicultural activities [prescribed fire, oak, pine, plantations, and POC sanitation treatment units], sustainable road treatments [decommissioning, storage, and openings], recreation improvements, and aquatic habitat improvements) in the project area, and areas downslope of these areas that could be impacted by soil movement/slope instability. This cumulative effects analysis area is considered sufficient because effects to a particular soil is localized to the defined area where direct and indirect effects can be measured. The temporal scope for cumulative effects analysis is thirty years into the future, approximately the timeframe when reentry onto NFS lands in the project area is anticipated to address increases in forest stand density and fuel loading.

Past actions in these areas which still have the potential for residual effects to soils include timber management, recreation infrastructure, and wildfires. Timber management has occurred within 53 of the proposed plantation units. Previous intensive timber management activities in the project mostly consisted of clearcut regeneration harvests, but also included some limited salvage and partial retention regeneration harvests. Typically these treatments involved the removal of all or most of the overstory, slash was burned in broadcast burns, and the areas were planted with Douglas-fir. These units and their estimated current condition are shown in Table 9, and are included in proposed treatments for Alternative 1, Alternative 2, and Alternative 3. The 1970 Quail Fire, located in the Stair Creek watershed, intersects the proposed treatment activities. However, there has been 46 years of passive recovery in this area, where no management activities or wildfires have occurred since this past natural disturbance, and soils are likely to be recovered. Although, the Biscuit Fire of 2002 and the Blossom Fire of 2005 happened within the planning area, no activities overlap with the burn scar. Any other fuels management or prescribed fires within the area would be coordinated with this project, and burn plans and objectives likely would have similar soils protections and be complementary to this project's ecosystem restoration focus. Detrimental effects from wildfire would have been the loss or reduction of surface organic matter that provides nutrients, water retention, and effective ground cover from erosion on high severity and moderate severity sites. Since 46 years have passed since the Quail Fire it is likely soils have been recovered. A review of burn severity was not available for the Quail Fire of 1970.

Recreation infrastructure reflects locations where soil productivity already has been dedicated to a different use. At this time, there are no other new recreational infrastructure project proposals within, up, or downslope of the action alternatives described here. The existing Forest system roads also represent locations where soil productivity has been dedicated to other uses. There are no new system roads proposed within the planning area under separate NEPA decisions.

Present and reasonably foreseeable actions within the proposed treatment activities footprint include: commercial thinning, fuels treatments, removal of meadow encroachment, and ongoing grazing. Commercial thinning within the planning area has some areas that are currently included in a timber sale contracts (Hobby – 2011 and Green Knob Re-Offer – 2016 under CHFT), but have not been treated yet. Additional commercial thinning is likely to occur within the planning area in concurrence with potential implementation of Shasta Agness. This includes plantations covered under the Coastal Healthy Forest Treatments EA. However, these activities do not overlap with the treatment units identified for Shasta Agness, and would not cumulatively add to

the disturbance associated with Shasta Agness. Funding dependent work (also covered under existing NEPA decisions) that may be implemented includes fuel reduction adjacent to private property, precommercial thinning, and removal of meadow encroachment. Allotments are expected to continue with current grazing operations. The majority (70%) of these activities would occur in Shasta Costa Creek – Rogue River watershed. Given the project design criteria, the proposed prescriptions, the anticipated burn plan considerations, and the BMP requirements, effects from these other actions combined with the potential effects from the action alternatives are not expected to result in cumulative detrimental impacts to soil productivity or slope stability.

1. **Alternative 1, 2, and 3**

All Action Alternatives would result in similar cumulative effects (compaction, displacement, erosion, burning, loss of OM, etc.) to soil productivity and stability, because similar past, present, and foreseeable actions occurred or will occur throughout the treatment activity sites, although fewer acres would be treated in Alternative 2 and Alternative 3 for unique landscape restoration treatments; fewer miles of sustainable road treatments would occur in Alternative 1 and 2 (includes miles of non-system road templates reused and rehabilitated); and under sustainable recreation improvements Alternative 1 and 3 would disturb less acres of soil from new construction of sites in comparison to alternative 2. No new temporary roads would be constructed under Alternative 3 leading to less impact to soil productivity over the duration of the Project. Sustainable road treatments would have the net effect of returning approximately: 85 acres under Alternative 1, 64 acres under Alternative 2, and 91 acres under Alternative 3, back to forest productivity. Since there are no measureable effects to soil productivity or stability from aquatic and riparian habitat treatments there would be no expected cumulative effects associated under the action alternatives. Sustainable recreation treatment activities would have a net effect of returning approximately 11 acres under Alternative 1 and 3 back to forest productivity in comparison to zero from Alternative 2.

The Siskiyou National Forest Land and Resource Management Plan establishes that the total area of detrimental soil conditions should not exceed 15 percent of the total acreage within the activity area, including roads and landings. Where a unit is already estimated to be over 15 percent detrimentally disturbed (Siskiyou NF Plan, vs. 20 percent in the R6 Manual) from past impacts, the Region 6 Manual requires that “the cumulative detrimental effects of project implementation and restoration must, at a minimum, not exceed the conditions prior to the planned activity and should move toward a net improvement in soil quality” (USFS 1998). During preparation for implementation, treatment methods are designed to assure that soil detrimental disturbance will not exceed this Standard and Guideline. In areas where there are residual past effects, then the re-use of old disturbance areas to the maximum extent possible helps to prevent an increase in the acres. In addition, required mitigation measures to improve effective ground cover and water infiltration, such as through slash placement and subsoiling, improve the disturbed areas and set the soil resource on a trajectory of restored soil productivity.

2. **Alternative 4**

Under the No Action alternative soil recovery and soil stability, combined with the effects of other past, present, or reasonably foreseeable future actions, would continue within the treatment activity areas without major disturbance, and as a result, there would be no cumulative effects associated with Alternative 4. Livestock grazing would continue in the cumulative effects analysis area with minor impacts to soil productivity as the percent overlapping treatment activity areas is less than 1%. Detrimental soil conditions would persist at current levels, with passive restoration occurring over time.

Under the No Action alternative, fuel build-up and stand conditions would continue to develop on NFS lands and would increase the likelihood of large, stand-replacing wildfire. Large, stand-replacing fire would have potential short- and long-term adverse effects to soil productivity through erosion, volatilization of soil nutrients, and adverse alteration of soil physical characteristics. Overall, the adverse effects of the No Action alternative in the event of wildfire would combine with the effects of other past, present, or reasonably foreseeable future actions to produce an adverse cumulative effect on soil productivity.

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Appendix 1: Soil Characteristics and Management Limitations of Silviculture Activities

Table 17. Oak Savannah soil characteristics and management limitations of the Shasta Agness Planning Area.

Map Unit	Map Unit Name	Taxonomic Classification	Soil Characteristics	Major Management Limitations
1B	Abegg gravelly loam, 2 to 7 percent slopes	Loamy-skeletal, mixed, mesic Ultic Haploxeralfs	Abegg (85%) : Deep; well-drained; surface-gravelly loam/ 11" depth; subsoil- v. gravelly loam, extremely cobbly clay loam, and extremely gravelly loamy sand; AWC- about 5" depth; located on gently sloping areas and high stream terraces.	Abegg - Susceptibility of the surface layer to compaction when wet, droughtiness in summer, low available water capacity.
8E	Atring-Kanid-Vermisa complex, 12 to 30 percent slopes	Loamy-skeletal, mixed, mesic Dystric Xerochrepts	Atring (35%) : Moderately deep; well drained; surface- v. gravelly loam/ 7" depth; subsoil- v. gravelly clay loam, v. gravelly loam; AWC- about 3" located on convex areas of summits. Kanid (30%) : Deep; well drained; surface-v. gravelly loam/5" depth; subsoil- v. gravelly clay loam; AWC- about 4"; located on concave areas of summits. Vermisa (25%) : Shallow; somewhat excessively drained; surface- v. gravelly loam/3" depth; subsoil- extremely gravelly loam; AWC- about 1"; located on shoulders, convex areas of summits.	Atring, Kanid, and Vermisa - susceptibility of the surface layer to compaction when wet, droughtiness in summer, low available water capacity.
9F	Atring-Kanid-Vermisa complex, 30 to 60 percent south slopes	Loamy-skeletal, mixed, mesic Dystric Xerochrepts	Atring (40%) : Moderately deep; well drained; surface- v. gravelly loam/ 7" depth; subsoil- v. gravelly clay loam and v. gravelly loam; AWC- about 3"; located on convex areas of backslopes. Kanid (30%) : Deep; well drained; surface-v. gravelly loam/5" depth; subsoil- v. gravelly clay loam; AWC- about 4"; located on concave areas of backslopes. Vermisa (20%) : Shallow; somewhat excessively drained; surface- v. gravelly loam/3" depth; subsoil- extremely gravelly loam; AWC- about 1"; located on narrow summits, shoulders, convex areas of backslopes.	Atring, Kanid, and Vermisa -slope, susceptibility of the surface layer to water erosion, susceptibility of the surface layer to displacement and accelerated erosion, susceptibility of the surface layer to compaction when wet, slope stability, south aspects, droughtiness in summer, low available water capacity.
9G	Atring-Kanid-Vermisa complex, 60 to 90 percent south slopes	Loamy-skeletal, mixed, mesic Dystric Xerochrepts	Atring (35%) : Moderately deep; well drained; surface- v. gravelly loam/ 7" depth; subsoil- v. gravelly clay loam and v. gravelly loam; AWC- about 3"; located on convex areas of backslopes. Kanid (30%) : Deep; well drained; surface-v. gravelly loam/5" depth; subsoil- v. gravelly clay loam; AWC- about 4"; located on concave areas of backslopes. Vermisa (25%) : Shallow; somewhat excessively drained; surface- v. gravelly loam/3" depth; subsoil- extremely gravelly loam; AWC- about 1"; located on narrow summits, shoulders, convex areas of backslopes.	Atring, Kanid, and Vermisa —slope, susceptibility of the surface layer to water erosion, susceptibility of the surface layer to displacement and accelerated erosion, susceptibility of the surface layer to compaction when wet, slope stability, south aspects, droughtiness in summer, low available water capacity. Atring and Vermisa —soil depth.
22F	Beekman-Colestine-Orthents complex, 30 to 60 percent south slopes	Loamy-skeletal, mixed, mesic Dystric Xerochrepts	Beekman (40%) : Moderately deep; well drained; surface- gravelly loam/ 5" depth; subsoil- v. gravelly loam and v. gravelly clay loam; AWC- about 3"; located on convex areas of backslopes. Colestine (30%) : Moderately deep; well drained; surface- gravelly loam/ 5" depth; subsoil- gravelly loam and gravelly clay loam; AWC- about 4"; located on concave areas of backslopes.	Beekman, Colestine, and Orthents - slope, susceptibility of the surface layer to water erosion, susceptibility of the surface layer to displacement and accelerated erosion, susceptibility of the surface layer to compaction when wet, slope stability, soil depth, south aspects, droughtiness in summer, low available water capacity Orthents —moderately rapid to very rapid permeability.

			<p>Orthents (20%): Depth varies from shallow to deep; well drained to excessively drained; surface- extremely gravelly sandy loam to extremely cobbly clay loam/ 5" depth; subsoil- extremely gravelly loamy sand to extremely cobbly clay loam; AWC- about 0.2 to 6"; located on narrow summits, shoulders, and convex areas of backslopes.</p>	
23G	Beekman-Orthents-Colestine complex, 60 to 90 percent south slopes	Loamy-skeletal, mixed, mesic Dystric Xerochrepts	<p>Beekman (35%): Moderately deep; well drained; surface- gravelly loam/ 5" depth; subsoil- v. gravelly loam and v. gravelly clay loam; AWC- about 3"; located on convex areas of backslopes.</p> <p>Orthents (30%): Depth varies from shallow to deep; well drained to excessively drained; surface- extremely gravelly sandy loam to extremely cobbly clay loam/ 5" depth; subsoil- extremely gravelly loamy sand to extremely cobbly clay loam; AWC- about 0.2 to 6"; located on narrow summits, shoulders, convex areas of backslopes.</p> <p>Colestine(25%): Moderately deep; well drained; surface- gravelly loam/ 5" depth; subsoil- gravelly loam and gravelly clay loam; AWC- about 4"; located on concave areas of backslopes.</p>	<p>Beekman, Colestine, and Orthents- slope, susceptibility of the surface layer to water erosion, susceptibility of the surface layer to displacement, and accelerated erosion, susceptibility of the surface layer to compaction when wet, slope stability, soil depth, south aspects, droughtiness in summer, low available water capacity.</p> <p>Orthents- moderately rapid to very rapid permeability.</p>
25G	Beekman-Vermisa complex, 60 to 90 percent south slopes	Loamy-skeletal, mixed, mesic Dystric Xerochrepts	<p>Beekman (45%): Moderately deep; well drained; surface- gravelly loam/ 5" depth; subsoil- v. gravelly loam and v. gravelly clay loam; AWC- about 3"; located on convex areas of backslopes.</p> <p>Vermisa (40%): Shallow; somewhat excessively drained; surface- v. gravelly loam/3" depth; subsoil- extremely gravelly loam; AWC- about 1"; located on narrow summits, shoulders, and convex areas of backslopes.</p>	<p>Beekman and Vermisa—slope, susceptibility of the surface layer to water erosion, susceptibility of the surface layer to displacement and accelerated erosion, susceptibility of the surface layer to compaction when wet, slope stability, soil depth, south aspects, droughtiness in summer, low available water capacity.</p>
61A	Clawson sandy loam, 0 to 3 percent slopes	Coarse-loamy, mixed, nonacid, mesic Typic Endoaquepts	<p>Clawson (85%): Very deep; poorly drained; surface- sandy loam/ 5" depth; subsoil- sandy loam and coarse sandy loam; AWC- about 7"; located on concave areas and low stream terraces.</p>	<p>Clawson- High water table, susceptibility of the surface layer to compaction when wet, droughtiness in summer, limited rooting depth, moderately rapid permeability.</p>
104E	Eightlar-Gravecreek-Pearsoll complex, 3 to 30 percent slopes	Clayey-skeletal, serpentinitic, mesic Typic Xerochrepts	<p>Eightlar (35%): Very deep; well drained; surface- v. stony clay loam/ 13" depth; subsoil- extremely stony clay; AWC- about 4"; located on concave areas of summits.</p> <p>Gravecreek (30%): Moderately deep; well drained; surface- v. cobbly loam/ 4" depth; subsoil- v. gravelly loam, v. cobbly clay loam; AWC- about 3"; located on convex areas of summits.</p> <p>Pearsoll (25%): Shallow; well drained; surface- v. cobbly clay loam/ 4" depth; subsoil- extremely cobbly clay; AWC- about 1"; located on shoulders, knobs, convex areas of summits.</p>	<p>Eightlar, Gravecreek, and Pearsoll- toxicity, cobbles and stones on the surface, susceptibility of the surface layer to compaction when wet, slope stability, droughtiness in summer, low available water capacity.</p> <p>Eightlar and Pearsoll-clayey textures, high shrink-swell potential, very slow and slow permeability.</p> <p>Gravecreek and Pearsoll- soil depth.</p>
112A	Evans silt loam, 0 to 3 percent slopes	Coarse-loamy, mixed, mesic Cumulic Haploxerolls	<p>Evans (85%): Very deep; well drained; surface- silt loam/ 39" depth; subsoil- v. fine sandy loam; AWC- about 11"; located on nearly level to slightly convex areas.</p>	<p>Evans- Flooding, susceptibility of the surface layer to compaction when wet, droughtiness in summer.</p>
119A	Foehlin-Cove complex, 0 to 3 percent slopes	Fine-loamy, mixed, mesic Typic Argixerolls	<p>Foehlin (60%):Very deep; well drained; surface- gravelly loam/ 13" depth; subsoil- gravelly clay loam; AWC- about 10"; located on nearly level areas.</p> <p>Cove (25%): Very deep; poorly drained; surface- silty clay loam/ 8" depth; subsoil- silty clay; AWC- about 9"; located on depressions and drainageways.</p>	<p>Foehlin and Cove- susceptibility of the surface layer to compaction when wet, droughtiness in summer.</p> <p>Cove- rare flooding, high water table, clayey textures, limited rooting depth, high shrink-swell potential, very slow permeability.</p>

132F	Gravecreek-Eightlar-Pearsoll complex, 30 to 60 percent south slopes	Loamy-skeletal, serpentinitic, mesic Dystric Xerochrepts	<p>Gravecreek (35%): Moderately deep; well drained; surface- v. cobbly loam/ 4" depth; subsoil- v. gravelly clay loam and v. cobbly clay loam; AWC- about 3"; located on convex areas of backslopes.</p> <p>Eightlar (30%): Very deep; well drained; surface- v. stony clay loam/ 13" depth; subsoil- extremely stony clay; AWC- about 4"; located on concave areas of backslopes.</p> <p>Pearsoll (25%): Shallow; well drained; surface- v. cobbly clay loam/ 4" depth; subsoil- extremely cobbly clay; AWC- about 1"; located on narrow summits, shoulders, convex areas of backslopes.</p>	<p>Gravecreek, Eightlar, and Pearsoll- toxicity, slope, susceptibility of the surface layer to water erosion, cobbles and stones on the surface, susceptibility of the surface layer to displacement and accelerated erosion, susceptibility of the surface layer to compaction when wet, slope stability, south aspects, droughtiness in summer, low available water capacity.</p> <p>Eightlar and Pearsoll- clayey textures, high shrink-swell potential.</p> <p>Gravecreek and Pearsoll- soil depth</p> <p>Eightlar- very slow permeability.</p> <p>Pearsoll- slow permeability.</p>
158F	Kanid-Acker-Atring complex, 30 to 60 percent north slopes	Loamy-skeletal, mixed, mesic Dystric Xerochrepts	<p>Kanid (40%): Deep; well drained; surface- gravelly loam/ 5" depth; subsoil- v. gravelly clay loam; AWC- 4"; located on concave areas of backslopes.</p> <p>Acker (30%): Very deep; well drained; surface- gravelly loam/ 9" depth; subsoil- gravelly clay loam; AWC- about 9"; located on footslopes, concave areas of backslopes.</p> <p>Atring (20%): Moderately deep; well drained surface- v. gravelly loam/ 7" depth; subsoil- v. gravelly clay loam and v. gravelly loam; AWC- about 3"; located on convex areas of backslopes.</p>	<p>Kanid, Acker, and Atring—slope, susceptibility of the surface layer to water erosion, susceptibility of the surface layer to displacement and accelerated erosion, susceptibility of the surface layer to compaction when wet, slope stability, droughtiness in summer.</p> <p>Kanid and Atring—low available water capacity.</p> <p>Atring—soil depth.</p>
159F	Kanid-Acker-Atring complex, 30 to 60 percent south slopes	Loamy-skeletal, mixed, mesic Dystric Xerochrepts	<p>Kanid (35%): Deep; well drained; surface- gravelly loam/ 5" depth; subsoil- v. gravelly clay loam; AWC- 4"; located on concave areas of backslopes.</p> <p>Acker (30%): Very deep; well drained; surface- gravelly loam/ 9" depth; subsoil- gravelly clay loam; AWC- about 9"; located on footslopes, concave areas of backslopes.</p> <p>Atring (25%): Moderately deep; well drained surface- v. gravelly loam/ 7" depth; subsoil- v. gravelly clay loam and v. gravelly loam; AWC- about 3"; located on convex areas of backslopes.</p>	<p>Kanid, Acker, and Atring—slope, susceptibility of the surface layer to water erosion, susceptibility of the surface layer to displacement and accelerated erosion, susceptibility of the surface layer to compaction when wet, slope stability, south aspects, droughtiness in summer.</p> <p>Kanid and Atring—low available water capacity.</p> <p>Atring—soil depth.</p>
196C	Pollard loam, 2 to 15 percent slopes	Clayey, kaolinitic, mesic Typic Palixerults	Pollard (85%) : Very deep; well drained; surface- loam/ 10" depth; subsoil- clay loam and silty clay; AWC- about 10"; located on toeslopes.	Pollard —Susceptibility of the surface layer to compaction when wet, clayey textures, droughtiness in summer.
196D	Pollard loam, 15 to 30 percent slopes	Clayey, kaolinitic, mesic Typic Palixerults	Pollard (85%) : Very deep; well drained; surface- loam/ 10" depth; subsoil- clay loam and silty clay; AWC- about 10"; located on footslopes.	Pollard —Slope, susceptibility of the surface layer to compaction when wet, susceptibility of the surface layer to displacement and accelerated erosion, clayey textures, droughtiness in summer.
197E	Pollard-Josephine-Shastacosta complex, 2 to 30 percent slopes	Clayey, kaolinitic, mesic Typic Palixerults	<p>Pollard (40%): Very deep; well drained; surface- gravelly loam/ 10" depth; subsoil- clay loam and silty clay; AWC- about 10"; located on concave areas of summits.</p> <p>Josephine (30%): Deep; well drained; surface- gravelly loam/ 15" depth; subsoil- gravelly clay loam; AWC- 8"; located on convex areas of summits.</p> <p>Shastacosta (20%): Very deep; well drained; surface- v. gravelly loam/ 22" depth; subsoil- v. gravelly clay loam, extremely cobbly clay loam; v. cobbly clay loam, and v. gravelly clay; AWC- about 6"; located on concave areas of summits.</p>	<p>Pollard, Josephine, and Shastacosta—slope, susceptibility of the surface layer to compaction when wet, droughtiness in summer.</p> <p>Pollard—clayey textures.</p> <p>Josephine—susceptibility of the surface layer to displacement and accelerated erosion.</p> <p>Shastacosta—high shrink-swell potential, slow permeability.</p>

221B	Ruch-Selmac complex, 2 to 7 percent slopes	Fine-loamy, mixed, mesic Mollic Palixeralfs	<p>Ruch (45%): Very deep; well drained; surface- loam/ 8" depth; subsoil- clay loam; AWC- about 11"; located on convex areas on high stream terraces.</p> <p>Selmac(40%): Very deep; moderately well drained; surface- loam/ 5" depth; subsoil- clay loam, gravelly clay loam, and silty clay; AWC- about 12"; located on concave areas on high stream terraces.</p>	<p>Ruch and Selmac—susceptibility of the surface layer to compaction when wet, susceptibility of the surface layer to displacement and accelerated erosion, droughtiness in summer.</p> <p>Selmac—high water table, limited rooting depth, high shrink-swell potential, clayey textures, very slow permeability.</p>
221D	Ruch-Selmac complex, 7 to 20 percent slopes	Fine-loamy, mixed, mesic Mollic Palixeralfs	<p>Ruch (55%): Very deep; well drained; surface- loam/ 8" depth; subsoil- clay loam; AWC- about 11"; located on convex areas on high stream terraces.</p> <p>Selmac(30%): Very deep; moderately well drained; surface- loam/ 5" depth; subsoil- clay loam, gravelly clay loam, and silty clay; AWC- about 12"; located on concave areas on high stream terraces.</p>	<p>Ruch and Selmac—slope, susceptibility of the surface layer to compaction when wet, susceptibility of the surface layer to displacement and accelerated erosion, droughtiness in summer.</p> <p>Selmac—high water table, limited rooting depth, high shrink-swell potential, clayey textures, very slow permeability.</p>
233F	Shastacosta-Beekman complex, 30 to 60 percent south slopes	Loamy-skeletal, mixed, mesic Typic Palexerults	<p>Shastacosta (35%): very deep; well drained; surface- v. gravelly loam/ 22" depth; subsoil- v. gravelly clay loam, extremely cobbly clay loam, v. cobbly clay, and v. gravelly clay; AWC- about 6"; located on concave areas of backslopes.</p> <p>Pollard (30%): Very deep; well drained; surface- loam/ 10" depth; subsoil- clay loam and silty clay; AWC- about 10"; located on footslopes, concave areas of backslopes.</p> <p>Beekman (25%): Moderately deep; well drained; surface- gravelly loam/ 5" depth; subsoil- v. gravelly loam and v. gravelly clay loam; AWC- about 3"; located on narrow summits, shoulders, convex areas of backslopes.</p>	<p>Shastacosta, Pollard, and Beekman—slope, susceptibility of the surface layer to water erosion, susceptibility of the surface layer to displacement and accelerated erosion, susceptibility of the surface layer to compaction when wet, slope stability, south aspects, droughtiness in summer.</p> <p>Shastacosta—high shrink-swell potential, slow permeability.</p> <p>Pollard—clayey textures.</p> <p>Beekman—soil depth, low available water capacity.</p>
267F	Vermisa-Beekman-Colestine complex, 30 to 60 percent south slopes	Loamy-skeletal, mixed, mesic Lithic Xerochrepts	<p>Vermisa (40%): Shallow; somewhat excessively drained; surface- v. gravelly loam/ 3" depth; subsoil- extremely gravelly loam; AWC- about 1"; located on narrow summits, shoulders, convex areas of backslopes.</p> <p>Beekman (30%): Moderately deep; well drained; surface- gravelly loam/ 5" depth; subsoil- v. gravelly loam and v. gravelly clay loam; AWC- about 3"; located on convex areas of backslopes.</p> <p>Colestine (20%): Moderately deep; well drained; surface- gravelly loam/ 5" depth; subsoil- gravelly loam and gravelly clay loam; AWC- about 4"; located on concave areas of backslopes.</p>	<p>Vermisa, Beekman, and Colestine—slope, susceptibility of the surface layer to water erosion, susceptibility of the surface layer to displacement and accelerated erosion, susceptibility of the surface layer to compaction when wet, slope stability, soil depth, south aspects, droughtiness in summer, low available water capacity.</p>

Table 18. Sugar pine soil characteristics and management limitations for the Shasta Agness Planning Area.

Map Unit	Map Unit Name	Taxonomic Classification	Soil Characteristics	Major Management Limitations
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28F	Bobsgarden-Rilea-Euchrand complex, 30 to 60 percent south slopes	Loamy-skeletal, mixed, frigid Umbric Dystrochrepts	<p>Bobsgarden (35%): Very deep; well-drained; surface- gravelly loam/8"; subsoil- v. gravelly clay loam; AWC- about 6"; located on concave areas of backslopes.</p> <p>Rilea (30%): Moderately deep; well drained; surface – v. gravelly loam/5" depth; subsoil – v. gravelly loam and v. gravelly clay loam; AWC- about 3"; located on convex areas of backslopes.</p> <p>Euchrand (25%): Shallow; well drained; surface – v. gravelly loam/3" depth; subsoil – extremely gravelly loam; AWC- about 1"; located on narrow summits, shoulders, convex areas of backslopes.</p>	<p>Bobsgarden, Rilea, and Euchrand—slope, susceptibility of the surface layer to water erosion, susceptibility of the surface layer to displacement and accelerated erosion, susceptibility of the surface layer to compaction when wet, duration of snow cover, short growing season, frost heave, slope stability, south aspects.</p> <p>Rilea and Euchrand—soil depth, low available water capacity.</p>
31F	Bobsgarden-Rilea-Rock outcrop complex, 30 to 60 percent south slopes	Loamy-skeletal, mixed, frigid Umbric Dystrochrepts	<p>Bobsgarden (35%): Very deep; well-drained; surface- gravelly loam/8"; subsoil- v. gravelly clay loam; AWC- about 6"; located on concave areas of backslopes.</p> <p>Rilea (30%): Moderately deep; well drained; surface – v. gravelly loam/5" depth; subsoil – v. gravelly loam and v. gravelly clay loam; AWC- about 3"; located on convex areas of backslopes.</p> <p>Rock outcrop (25%): Located on ridge crests, shoulders.</p>	<p>Bobsgarden and Rilea—slope, susceptibility of the surface layer to water erosion, susceptibility of the surface layer to displacement and accelerated erosion, susceptibility of the surface layer to compaction when wet, duration of snow cover, short growing season, frost heave, slope stability.</p> <p>Rilea—soil depth, low available water capacity.</p>
33E	Bobsgarden-Rilea-Yorel complex, 0 to 30 percent slopes	Loamy-skeletal, mixed, frigid Umbric Dystrochrepts	<p>Bobsgarden(40%): Very deep; well-drained; surface- gravelly loam/8"; subsoil- v. gravelly clay loam; AWC- about 6"; located on concave areas of summits.</p> <p>Rilea (30%): Moderately deep; well drained; surface – v. gravelly loam/5" depth; subsoil – v. gravelly loam and v. gravelly clay loam; AWC- about 3"; located on shoulders, knobs, convex areas of summits.</p> <p>Yorel (20%): Moderately deep; well drained; surface – v. gravelly loam/12" depth; subsoil – gravelly clay loam; AWC- about 4"; located on convex areas of summits.</p>	<p>Bobsgarden, Rilea, and Yorel—susceptibility of the surface layer to compaction when wet, duration of snow cover, short growing season, frost heave, slope stability.</p> <p>Bobsgarden and Yorel—susceptibility of the surface layer to displacement and accelerated erosion.</p> <p>Rilea and Yorel—soil depth, low available water capacity.</p> <p>Yorel—susceptibility of the surface layer to water erosion.</p>
53D	Serpentano very stony loam, 10 to 35 percent slopes	Loamy-skeletal, serpentinitic, mesic Dystric Eutrochrepts	<p>Serpentano (75%): Deep; well-drained; surface- very stony loam/ 5" depth; subsoil- gravelly and v. cobbly loams; AWC- 4 to 7"; located on side slopes and ridgetops of mountains.</p>	<p>Serpentano- The main limitations for the management of timber on this unit are the hazard of erosion, the hazard of windthrow, and seedling mortality.</p>
53E	Serpentano very stony loam, 35 to 70 percent slopes	Loamy-skeletal, serpentinitic, mesic Dystric Eutrochrepts	<p>Serpentano (80%): Deep; well-drained; surface- very stony loam/ 5" depth; subsoil- gravelly and v. cobbly loams; AWC- 4 to 7"; located on side slopes and ridgetops of mountains.</p>	<p>Serpentano- The main limitations for the management of timber on this unit are the hazard of erosion, steepness of slope, the hazard of windthrow, and seedling mortality.</p>

53F	Cedarcamp-Snowcamp-Flycatcher complex, 30 to 60 percent north slopes	Loamy-skeletal, serpentinitic, frigid Dystric Eutrochrepts	<p>Atring (40%): Moderately deep; well drained; surface- v. gravelly loam/ 7" depth; subsoil- v. gravelly clay loam and v. gravelly loam; AWC- about 3"; located on convex areas of backslopes.</p> <p>Kanid (30%): Deep; well drained; surface- v. gravelly loam/5" depth; subsoil- v. gravelly clay loam; AWC- about 4"; located on concave areas of backslopes.</p> <p>Vermisa (20%): Shallow; somewhat excessively drained; surface- v. gravelly loam/3" depth; subsoil- extremely gravelly loam; AWC- about 1"; located on narrow summits, shoulders, convex areas of backslopes.</p>	Atring, Kanid, and Vermisa —slope, susceptibility of the surface layer to water erosion, susceptibility of the surface layer to displacement and accelerated erosion, susceptibility of the surface layer to compaction when wet, slope stability, south aspects, droughtiness in summer, low available water capacity.
54F	Cedarcamp-Snowcamp-Flycatcher complex, 30 to 60 percent south slopes	Loamy-skeletal, serpentinitic, frigid Dystric Eutrochrepts	<p>Cedarcamp (35%): Very deep; well drained; surface- v. gravelly loam/ 6"; subsoil- v. cobbly clay loam, extremely cobbly loam, and extremely cobbly clay loam; AWC- about 5"; located on concave areas of backslopes.</p> <p>Snowcamp(30%): Moderately deep; well drained; surface- v. cobbly loam/ 6"; subsoil- v. cobbly clay loam and extremely cobbly clay loam; AWC- about 3"; located on convex areas of backslopes.</p> <p>Flycatcher(25%): Shallow; well drained; surface- v. cobbly loam/ 4"; subsoil- v. gravelly clay loam, v. gravelly sandy clay loam, and extremely gravelly loam; AWC- about 2"; located on narrow summits, shoulders, and convex areas of backslopes.</p>	Cedarcamp, Snowcamp, and Flycatcher —toxicity, slope, susceptibility of the surface layer to water erosion, susceptibility of the surface layer to displacement and accelerated erosion, susceptibility of the surface layer to compaction when wet, duration of snow cover, short growing season, frost heave, slope stability, south aspects, low available water capacity. Snowcamp and Flycatcher —soil depth.
56F	Cedarcamp-Snowcamp-Rock outcrop complex, 30 to 60 percent south slopes	Loamy-skeletal, serpentinitic, frigid Dystric Eutrochrepts	<p>Cedarcamp (35%): Very deep; well drained; surface- v. bouldery loam/ 6" depth; subsoil- v. cobbly loam, extremely cobbly loam, and extremely cobbly clay loam; AWC- about 5"; located on concave areas of backslopes.</p> <p>Snowcamp (30%): Moderately deep; well drained; surface- v. bouldery loam/ 4' depth; subsoil- v. cobbly clay loam and extremely cobbly clay loam; AWC- about 3"; located on convex areas of backslopes.</p> <p>Rock outcrop (25%): Located on ridge crests and shoulders.</p>	Cedarcamp and Snowcamp —toxicity, slope, boulders on the surface, susceptibility of the surface layer to water erosion, susceptibility of the surface layer to displacement and accelerated erosion, susceptibility of the surface layer to compaction when wet, duration of snow cover, short growing season, frost heave, slope stability, south aspects, low available water capacity. Snowcamp —soil depth.
88F	Digger-Remote-Umpcoos complex, warm, 30 to 60 percent south slopes	Loamy-skeletal, mixed, mesic Dystric Eutrochrepts	<p>Digger (35%): Moderately deep; well drained; surface - v. gravelly loam/16" depth; subsoil - v. gravelly loam, and v. cobbly loam; AWC- about 3"; located on convex areas of backslopes.</p> <p>Remote (30%): Very deep; well drained; surface- v. gravelly loam/ 6" depth; subsoil- gravelly loam and v. gravelly clay loam; AWC- about 6"; located on concave areas of backslopes.</p> <p>Umpcoos (25%): Shallow; well drained; surface- v. gravelly sandy loam/ 3" depth; subsoil- extremely gravelly loam; AWC- about 1"; located on narrow summits,</p>	Digger, Remote, and Umpcoos —slope, susceptibility of the surface layer to water erosion, susceptibility of the surface layer to displacement and accelerated erosion, susceptibility of the surface layer to compaction when wet, slope stability, south aspects. Digger and Umpcoos —soil depth, low available water capacity.

			shoulders, convex areas of backslopes.	
90E	Digger-Remote complex, warm, 3 to 30 percent slopes	Loamy-skeletal, mixed, mesic Dystric Eutrochrepts	<p>Digger (45%): Moderately deep; well drained; surface - gravelly loam/16" depth; subsoil - v. gravelly loam and v. cobbly loam; AWC- about 3"; located on convex areas of summits.</p> <p>Remote (40%): Very deep; well drained; surface- gravelly loam/ 14"; subsoil- v. gravelly clay loam; AWC- about 6" depth; located on gently sloping areas of summits.</p>	<p>Digger and Remote—slope, susceptibility of the surface layer to displacement and accelerated erosion, susceptibility of the surface layer to compaction when wet, slope stability.</p> <p>Digger—susceptibility of the surface layer to water erosion, soil depth, and low available water capacity.</p>
91F	Digger-Umpcoos-Dystrochrepts complex, warm, 30 to 60 percent south slopes	Loamy-skeletal, mixed, mesic Dystric Eutrochrepts	<p>Digger (35%): Moderately deep; well drained; surface - v. gravelly loam/16" depth; subsoil - v. cobbly loam; AWC- about 3"; located on concave areas of backslopes.</p> <p>Umpcoos (30%): Shallow; well drained; surface- v. gravelly sandy loam/ 3"; subsoil- extremely gravelly loam; AWC- about 1"; located on narrow summits, shoulders, convex areas of backslopes.</p> <p>Dystrochrepts (25%): Moderately deep to very deep; well drained to excessively drained; surface- extremely gravelly loam to v. cobbly sandy loam/8" depth; subsoil- extremely stony clay loam to extremely gravelly sandy loam; AWC- about 1 to 4"; located on convex areas of backslopes.</p>	<p>Digger, Umpcoos, and Dystrochrepts—slope, susceptibility of the surface layer to water erosion, susceptibility of the surface layer to displacement and accelerated erosion, susceptibility of the surface layer to compaction when wet, slope stability, soil depth, south aspects, low available water capacity.</p>
91G	Digger-Umpcoos-Dystrochrepts complex, warm, 60 to 90 percent south slopes	Loamy-skeletal, mixed, mesic Dystric Eutrochrepts	<p>Digger (35%): Moderately deep; well drained; surface - v. gravelly loam/16" depth; subsoil - v. cobbly loam; AWC- about 3"; located on concave areas of backslopes.</p> <p>Umpcoos (30%): Shallow; well drained; surface- v. gravelly sandy loam/ 3"; subsoil- extremely gravelly loam; AWC- about 1"; located on narrow summits, shoulders, convex areas of backslopes.</p> <p>Dystrochrepts (25%): Moderately deep to very deep; well drained to excessively drained; surface- extremely gravelly loam to v. cobbly sandy loam/8" depth; subsoil- extremely stony clay loam to extremely gravelly sandy loam; AWC- about 1 to 4"; located on convex areas of backslopes.</p>	<p>Digger, Umpcoos, and Dystrochrepts—slope, susceptibility of the surface layer to water erosion, susceptibility of the surface layer to displacement and accelerated erosion, susceptibility of the surface layer to compaction when wet, slope stability, soil depth, south aspects, low available water capacity.</p>
147E	Honeygrove-Shivigny complex, warm, 3 to 30 percent slopes	Clayey, mixed, mesic Typic Palehumults	<p>Honeygrove (55%): Very deep; well drained; surface- gravelly clay loam/ 15" depth; subsoil- clay and gravelly clay; AWC- about 12"; located on concave areas of summits.</p> <p>Shivigny (30%): Very deep; well drained; surface- v. gravelly loam/ 13" depth; subsoil- v. stony clay loam and v. stony clay; AWC- about 7"; located on convex areas of summits.</p>	<p>Honeygrove and Shivigny—susceptibility of the surface layer to displacement and accelerated erosion, susceptibility of the surface layer to compaction when wet, clayey textures, slope stability.</p>

211G	Rilea-Euchrand-Rock outcrop complex, 60 to 90 percent south slopes	Loamy-skeletal, mixed, frigid Typic Dystrichrepts	<p>Rilea (35%): Moderately deep; well drained; surface – v. gravelly loam/5" depth; subsoil – v. gravelly loam and v. gravelly clay loam; AWC- about 3"; located on concave areas of backslopes.</p> <p>Euchrand (30%): Shallow; well drained; surface- v. gravelly loam/3" depth; subsoil- extremely gravelly loam; AWC- about 1"; located on convex areas of backslopes.</p> <p>Rock outcrop (25%): Located on ridge crests and shoulders.</p>	Rilea and Euchrand —slope, susceptibility of the surface layer to water erosion, susceptibility of the surface layer to displacement and accelerated erosion, susceptibility of the surface layer to compaction when wet, duration of snow cover, short growing season, frost heave, slope stability, soil depth, south aspects, low available water capacity.
212G	Rilea-Stackyards-Rock outcrop complex, cool, 60 to 90 percent north slopes	Loamy-skeletal, mixed, frigid Typic Dystrichrepts	<p>Rilea (40%): Moderately deep; well drained; surface – v. gravelly loam/5" depth; subsoil – v. gravelly loam and v. gravelly clay loam; AWC- about 3"; located on convex areas of backslopes.</p> <p>Stackyards (30%): Deep; well drained; surface- extremely gravelly loam/ 10" depth; subsoil- extremely cobbly clay loam and extremely cobbly loam; AWC- 4"; located on concave areas of backslopes.</p> <p>Rock outcrop (20%): Located on ridge crests and shoulders.</p>	Rilea and Stackyards —slope, susceptibility of the surface layer to water erosion, duration of snow cover, short growing season, frost heave, slope stability, low available water capacity. Rilea —susceptibility of the surface layer to displacement and accelerated erosion, susceptibility of the surface layer to compaction when wet, soil depth.
230E	Serpentano-Mislatnah complex, 3 to 30 percent slopes	Loamy-skeletal, serpentinitic, mesic Dystric Eutrochrepts	<p>Serpentano (45%): Deep; well drained; surface- v. stony loam/ 6" depth; subsoil- v. gravelly clay loam; AWC- about 6"; located on concave areas of summits.</p> <p>Mislatnah (40%): Moderately deep; well drained; surface- cobbly clay loam/ 2" depth; subsoil- cobbly clay loam and v. cobbly clay loam; AWC- about 4"; located on convex areas of summits.</p>	Serpentano and Mislatnah —toxicity, susceptibility of the surface layer to water erosion, susceptibility of the surface layer to compaction when wet, slope stability. Mislatnah —susceptibility of the surface layer to displacement and accelerated erosion, soil depth, low available water capacity.
232F	Serpentano-Mislatnah-Greggo complex, 30 to 60 percent south slopes	Loamy-skeletal, serpentinitic, mesic Dystric Eutrochrepts	<p>Serpentano (35%): Deep; well drained; surface- v. stony loam/ 6" depth; subsoil- v. gravelly clay loam; AWC- about 6"; located on concave areas of backslopes.</p> <p>Mislatnah (30%): Moderately deep; well drained; surface- cobbly clay loam/ 2" depth; subsoil- cobbly clay loam and v. cobbly clay loam; AWC- about 4"; located on convex areas of backslopes.</p> <p>Greggo (25%): Shallow; well drained; surface- v. cobbly clay loam/ 4" depth; subsoil- extremely gravelly clay loam; AWC- about 1"; located on narrow summits, shoulders, and convex areas of backslopes.</p>	Serpentano, Mislatnah, and Greggo —toxicity, slope, susceptibility of the surface layer to water erosion, susceptibility of the surface layer to displacement and accelerated erosion, susceptibility of the surface layer to compaction when wet, slope stability, south aspects. Mislatnah and Greggo —soil depth, low available water capacity.
234F	Shivigny-Honeygrove complex, warm, 30 to 60 percent south slopes	Clayey-skeletal, mixed, mesic Typic Palehumults	<p>Shivigny (45%): Very deep; well drained; surface- v. gravelly loam/ 13" depth; subsoil- v. stony clay loam and v. stony clay; AWC- about 7"; located on convex areas of backslopes.</p> <p>Honeygrove (40%): Very deep; well drained; surface- gravelly clay loam/ 15" depth; subsoil- clay and gravelly clay; AWC- about 12"; located on concave areas of backslopes.</p>	Shivigny and Honeygrove —slope, susceptibility of the surface layer to water erosion, susceptibility of the surface layer to displacement and accelerated erosion, susceptibility of the surface layer to compaction when wet, slope stability, south aspects.

241E	Snowcamp-Cedarcamp-Rock outcrop complex, 0 to 30 percent slopes	Loamy-skeletal, serpentinitic, frigid Dystric Eutrochrepts	<p>Snowcamp (35%): Moderately deep; well drained; surface- v. cobbly loam/4" depth; subsoil- v. cobbly clay loam and extremely cobbly clay loam; AWC- about 3"; located on convex areas of summits.</p> <p>Cedarcamp (30%): Very deep; well drained; surface- v. bouldery loam/6" depth; subsoil- v. cobbly clay loam, extremely cobbly loam, and extremely cobbly clay loam; AWC- about 5"; located on concave areas of summits.</p> <p>Rock outcrop (25%): Located on ridge crests and shoulders.</p>	<p>Snowcamp and Cedarcamp—toxicity, boulders on the surface, susceptibility of the surface layer to compaction when wet, duration of snow cover, short growing season, frost heave, slope stability, low available water capacity.</p> <p>Snowcamp—susceptibility of the surface layer to water erosion, soil depth.</p>
242G	Snowcamp-Flycatcher-Rock outcrop complex, 60 to 90 percent south slopes	Loamy-skeletal, serpentinitic, frigid Dystric Eutrochrepts	<p>Snowcamp (35%): Moderately deep; well drained; surface- v. bouldery loam 4" depth; subsoil- v. cobbly clay loam and extremely cobbly clay loam; AWC- about 3"; located on concave areas of backslopes.</p> <p>Flycatcher (30%): Shallow; well drained; surface- v. bouldery loam/4" depth; subsoil- v. gravelly clay loam, v. gravelly sandy clay loam, and extremely gravelly loam; AWC- about 2"; located on convex areas of backslopes.</p> <p>Rock outcrop (25%): Located on ridge crests and shoulders.</p>	<p>Snowcamp and Flycatcher—toxicity, slope, boulders on the surface, susceptibility of the surface layer to water erosion, susceptibility of the surface layer to displacement and accelerated erosion, susceptibility of the surface layer to compaction when wet, duration of snow cover, short growing season, frost heave, slope stability, soil depth, south aspects, low available water capacity.</p>
264F	Threetrees-Scalerock-Rock outcrop complex, 30 to 60 percent south slopes	Loamy-skeletal, mixed, frigid Typic Dystrichrepts	<p>Threetrees (35%): Moderately deep; well drained; surface- v. channery loam/ 13" depth; subsoil- v. channery clay loam and v. flaggy clay loam; AWC- about 3"; located on convex areas of backslopes;</p> <p>Scalerock(30%): Shallow; well drained; surface- v. channery loam/ 4" depth; subsoil- v. flaggy clay loam; AWC- about 1"; located on narrow summits, shoulders, convex areas of backslopes..</p> <p>Rock outcrop (25%): Located on ridge crests and shoulders.</p>	<p>Threetrees and Scalerock—slope, susceptibility of the surface layer to water erosion, susceptibility of the surface layer to displacement and accelerated erosion, susceptibility of the surface layer to compaction when wet, duration of snow cover, short growing season, frost heave, slope stability, soil depth, poor anchoring medium, south aspects, low available water capacity.</p>
279E	Zalea-Yorel-Rock outcrop complex, 0 to 30 percent slopes	Fine-loamy, mixed, frigid Typic Haplohumults	<p>Zalea (35%): Moderately deep; well drained; surface- gravelly loam/ 8" depth; subsoil- gravelly clay loam; AWC- about 5"; located on concave areas of summits.</p> <p>Yorel (30%): Moderately deep; well drained; surface- gravelly loam/ 6" depth; subsoil- gravelly loam and gravelly clay loam; AWC- about 4"; located on convex areas of summits.</p> <p>Rock outcrop (25%): Located on ridge crests and shoulders.</p>	<p>Zalea and Yorel—susceptibility of the surface layer to displacement and accelerated erosion, susceptibility of the surface layer to compaction when wet, duration of snow cover, short growing season, frost heave, slope stability, soil depth, low available water capacity.</p> <p>Yorel—susceptibility of the surface layer to water erosion.</p>

Table 19. Serpentine pine soil characteristics and management limitations of the Shasta Agness Planning Area.

Map Unit	Map Unit Name	Taxonomic Classification	Soil Characteristics	Major Management Limitations
8E	Atring-Kanid-Vermisa complex, 12 to 30 percent slopes	Loamy-skeletal, mixed, mesic Dystric Xerochrepts	<p>Atring (35%): Moderately deep; well drained; surface- v. gravelly loam/ 7" depth; subsoil- v. gravelly clay loam, v. gravelly loam; AWC- about 3"; located on convex areas of summits.</p> <p>Kanid (30%): Deep; well drained; surface-v. gravelly loam/5" depth; subsoil- v. gravelly clay loam; AWC- about 4"; located on concave areas of summits.</p> <p>Vermisa (25%): Shallow; somewhat excessively drained; surface- v. gravelly loam/3" depth; subsoil- extremely gravelly loam; AWC- about 1"; located on shoulders, convex areas of summits.</p>	Atring, Kanid, and Vermisa —susceptibility of the surface layer to compaction when wet, droughtiness in summer, low available water capacity.
9F	Atring-Kanid-Vermisa complex, 30 to 60 percent south slopes	Loamy-skeletal, mixed, mesic Dystric Xerochrepts	<p>Atring (40%): Moderately deep; well drained; surface- v. gravelly loam/ 7" depth; subsoil- v. gravelly clay loam and v. gravelly loam; AWC- about 3"; located on convex areas of backslopes.</p> <p>Kanid (30%): Deep; well drained; surface-v. gravelly loam/5" depth; subsoil- v. gravelly clay loam; AWC- about 4"; located on concave areas of backslopes.</p> <p>Vermisa (20%): Shallow; somewhat excessively drained; surface- v. gravelly loam/3" depth; subsoil- extremely gravelly loam; AWC- about 1"; located on narrow summits, shoulders, convex areas of backslopes.</p>	Atring, Kanid, and Vermisa —slope, susceptibility of the surface layer to water erosion, susceptibility of the surface layer to displacement and accelerated erosion, susceptibility of the surface layer to compaction when wet, slope stability, south aspects, droughtiness in summer, low available water capacity.
53F	Cedarcamp-Snowcamp-Flycatcher complex, 30 to 60 percent north slopes	Loamy-skeletal, serpentinitic, frigid Dystric Eutrochrepts	<p>Atring (40%): Moderately deep; well drained; surface- v. gravelly loam/ 7" depth; subsoil- v. gravelly clay loam and v. gravelly loam; AWC- about 3"; located on convex areas of backslopes.</p> <p>Kanid (30%): Deep; well drained; surface-v. gravelly loam/5" depth; subsoil- v. gravelly clay loam; AWC- about 4"; located on concave areas of backslopes.</p> <p>Vermisa (20%): Shallow; somewhat excessively drained; surface- v. gravelly loam/3" depth; subsoil- extremely gravelly loam; AWC- about 1"; located on narrow summits, shoulders, convex areas of backslopes.</p>	Atring, Kanid, and Vermisa —slope, susceptibility of the surface layer to water erosion, susceptibility of the surface layer to displacement and accelerated erosion, susceptibility of the surface layer to compaction when wet, slope stability, south aspects, droughtiness in summer, low available water capacity.

54F	Cedarcamp-Snowcamp-Flycatcher complex, 30 to 60 percent south slopes	Loamy-skeletal, serpentinic, frigid Dystric Eutrochrepts	<p>Cedarcamp (35%): Very deep; well drained; surface- v. gravelly loam/ 6"; subsoil- v. cobbly clay loam, extremely cobbly loam, and extremely cobbly clay loam; AWC- about 5"; located on concave areas of backslopes.</p> <p>Snowcamp (30%): Moderately deep; well drained; surface- v. cobbly loam/ 6"; subsoil- v. cobbly clay loam and extremely cobbly clay loam; AWC- about 3"; located on convex areas of backslopes.</p> <p>Flycatcher(25%): Shallow; well drained; surface- v. cobbly loam/ 4"; subsoil- v. gravelly clay loam, v. gravelly sandy clay loam, and extremely gravelly loam; AWC- about 2"; located on narrow summits, shoulders, and convex areas of backslopes.</p>	<p>Cedarcamp, Snowcamp, and Flycatcher— toxicity, slope, susceptibility of the surface layer to water erosion, susceptibility of the surface layer to displacement and accelerated erosion, susceptibility of the surface layer to compaction when wet, duration of snow cover, short growing season, frost heave, slope stability, south aspects, low available water capacity.</p> <p>Snowcamp and Flycatcher— soil depth.</p>
74F	Deadline-Barkshanty-Rock outcrop complex, 30 to 60 percent north slopes	Loamy-skeletal, mixed, mesic Umbric Dystrichrepts	<p>Deadline (40%): Deep; well drained; surface- v. channery loam/ 8"; subsoil- v. channery loam, v. channery clay loam, extremely channery loam; AWC- about 4"; located on concave areas of backslopes.</p> <p>Barkshanty (30%): Very deep; well drained; surface- channery loam/ 5"; subsoil- channery clay loam, v. channery clay loam, v. flaggy clay loam, and extremely flaggy clay loam; AWC- about 6"; located on stable benches that have slopes of as much as 40 percent.</p> <p>Rock outcrop (20%): Located on ridge crests, shoulders.</p>	<p>Deadline and Barkshanty— slope, susceptibility of the surface layer to displacement and accelerated erosion, susceptibility of the surface layer to compaction when wet, slope stability</p> <p>Deadline— susceptibility of the surface layer to water erosion, poor anchoring medium, low available water capacity.</p>
80F	Deadline-Rock outcrop-Nailkeg complex, 30 to 60 percent south slopes	Loamy-skeletal, mixed, mesic Umbric Dystrichrepts	<p>Deadline (40%): Deep; well drained; surface- v. channery loam/ 8"; subsoil- v. channery loam, v. channery clay loam, extremely channery loam; AWC- about 4"; located on concave areas of backslopes.</p> <p>Rock outcrop (30%): Located on ridge crests and shoulders.</p> <p>Nailkeg (20%): Moderately deep; well drained; surface- v. channery loam/ 6"; subsoil- v. channery loam and v. channery clay loam; AWC- about 3"; located on convex areas of backslopes.</p>	<p>Deadline and Nailkeg— slope, susceptibility of the surface layer to water erosion, susceptibility of the surface layer to displacement and accelerated erosion, susceptibility of the surface layer to compaction when wet, slope stability, poor anchoring medium, south aspects, low available water capacity.</p> <p>Nailkeg— soil depth.</p>
88F	Digger-Remote-Umpcoos complex, warm, 30 to 60 percent south slopes	Loamy-skeletal, mixed, mesic Dystric Eutrochrepts	<p>Digger (35%): Moderately deep; well drained; surface - v. gravelly loam/ 16" depth; subsoil - v. gravelly loam, and v. cobbly loam; AWC- about 3"; located on convex areas of backslopes.</p> <p>Remote (30%): Very deep; well drained; surface- v. gravelly loam/ 6" depth; subsoil- gravelly loam and v. gravelly clay loam; AWC-</p>	<p>Digger, Remote, and Umpcoos— slope, susceptibility of the surface layer to water erosion, susceptibility of the surface layer to displacement and accelerated erosion, susceptibility of the surface layer to compaction when wet, slope stability, south aspects.</p> <p>Digger and Umpcoos— soil depth, low available water capacity.</p>

			about 6"; located on concave areas of backslopes. Umpcoos (25%) : Shallow; well drained; surface- v. gravelly sandy loam/ 3" depth; subsoil- extremely gravelly loam; AWC- about 1"; located on narrow summits, shoulders, convex areas of backslopes.	
90E	Digger-Remote complex, warm, 3 to 30 percent slopes	Loamy-skeletal, mixed, mesic Dystric Eutrochrepts	Digger (45%) : Moderately deep; well drained; surface - gravelly loam/16" depth; subsoil - v. gravelly loam and v. cobbly loam; AWC- about 3"; located on convex areas of summits. Remote (40%) : Very deep; well drained; surface- gravelly loam/ 14"; subsoil- v. gravelly clay loam; AWC- about 6" depth; located on gently sloping areas of summits.	Digger and Remote —slope, susceptibility of the surface layer to displacement and accelerated erosion, susceptibility of the surface layer to compaction when wet, slope stability. Digger —susceptibility of the surface layer to water erosion, soil depth, and low available water capacity.
91F	Digger-Umpcoos-Dystrochrepts complex, warm, 30 to 60 percent south slopes	Loamy-skeletal, mixed, mesic Dystric Eutrochrepts	Digger (35%) : Moderately deep; well drained; surface - v. gravelly loam/16" depth; subsoil - v. cobbly loam; AWC- about 3"; located on concave areas of backslopes. Umpcoos (30%) : Shallow; well drained; surface- v. gravelly sandy loam/ 3"; subsoil- extremely gravelly loam; AWC- about 1"; located on narrow summits, shoulders, convex areas of backslopes. Dystrochrepts (25%) : Moderately deep to very deep; well drained to excessively drained; surface- extremely gravelly loam to v. cobbly sandy loam/8" depth; subsoil- extremely stony clay loam to extremely gravelly sandy loam; AWC- about 1 to 4"; located on convex areas of backslopes.	Digger, Umpcoos, and Dystrochrepts —slope, susceptibility of the surface layer to water erosion, susceptibility of the surface layer to displacement and accelerated erosion, susceptibility of the surface layer to compaction when wet, slope stability, soil depth, south aspects, low available water capacity.
104E	Eightlar-Gravecreek-Pearsoil complex, 3 to 30 percent slopes	Clayey-skeletal, serpentinitic, mesic Typic Xerochrepts	Eightlar (35%) : Very deep; well drained; surface- v. stony clay loam/ 13" depth; subsoil- extremely stony clay; AWC- about 4"; located on concave areas of summits. Gravecreek (30%) : Moderately deep; well drained; surface- v. cobbly loam/ 4" depth; subsoil- v. gravelly loam, v. cobbly clay loam; AWC- about 3"; located on convex areas of summits. Pearsoil (25%) : Shallow; well drained; surface- v. cobbly clay loam/ 4" depth; subsoil- extremely cobbly clay; AWC- about 1"; located on shoulders, knobs, convex areas of summits.	Eightlar, Gravecreek, and Pearsoil —toxicity, cobbles and stones on the surface, susceptibility of the surface layer to compaction when wet, slope stability, droughtiness in summer, low available water capacity. Eightlar and Pearsoil —clayey textures, high shrink-swell potential, very slow and slow permeability. Gravecreek and Pearsoil —soil depth.

105F	Eightlar-Gravecreek-Pearsoll complex, 30 to 60 percent north slopes	Clayey-skeletal, serpentinitic, mesic Typic Xerochrepts	<p>Eightlar (40%): Very deep; well drained; surface- v. stony clay loam/ 13"; subsoil- extremely stony clay; AWC- about 4"; located on concave areas of backslopes.</p> <p>Gravecreek (30%): Moderately deep; well drained; surface- v. cobbly loam/ 4" depth; subsoil- v. gravelly clay loam and v. cobbly clay loam; AWC- about 3"; located on convex areas of backslopes.</p> <p>Pearsoll (20%): Shallow; well drained; surface- v. cobbly clay loam/ 4" depth; subsoil- extremely cobbly clay; AWC- about 1"; located on narrow summits, shoulders, and convex areas of backslopes.</p>	<p>Eightlar, Gravecreek, and Pearsoll—toxicity, slope, susceptibility of the surface layer to water erosion, cobbles and stones on the surface, susceptibility of the surface layer to displacement and accelerated erosion, susceptibility of the surface layer to compaction when wet, slope stability, droughtiness in summer, low available water capacity.</p> <p>Eightlar and Pearsoll—clayey textures, high shrink-swell potential, very slow and slow permeability.</p> <p>Gravecreek and Pearsoll—soil depth.</p>
132F	Gravecreek-Eightlar-Pearsoll complex, 30 to 60 percent south slopes	Loamy-skeletal, serpentinitic, mesic Dystric Xerochrepts	<p>Gravecreek (35%): Moderately deep; well drained; surface- v. cobbly loam/ 4" depth; subsoil- v. gravelly clay loam and v. cobbly clay loam; AWC- about 3"; located on convex areas of backslopes.</p> <p>Eightlar (30%): Very deep; well drained; surface- v. stony clay loam/ 13" depth; subsoil- extremely stony clay; AWC- about 4"; located on concave areas of backslopes.</p> <p>Pearsoll (25%): Shallow; well drained; surface- v. cobbly clay loam/ 4" depth; subsoil- extremely cobbly clay; AWC- about 1"; located on narrow summits, shoulders, convex areas of backslopes.</p>	<p>Gravecreek, Eightlar, and Pearsoll—toxicity, slope, susceptibility of the surface layer to water erosion, cobbles and stones on the surface, susceptibility of the surface layer to displacement and accelerated erosion, susceptibility of the surface layer to compaction when wet, slope stability, south aspects, droughtiness in summer, low available water capacity.</p> <p>Eightlar and Pearsoll—clayey textures, high shrink-swell potential.</p> <p>Gravecreek and Pearsoll—soil depth.</p> <p>Eightlar—very slow permeability.</p> <p>Pearsoll—slow permeability.</p>
133G	Gravecreek-Pearsoll-Eightlar complex, 60 to 90 percent south slopes	Loamy-skeletal, serpentinitic, mesic Dystric Xerochrepts	<p>Gravecreek (40%): Moderately deep; well drained; surface- v. cobbly loam/ 4" depth; subsoil- v. gravelly clay loam and v. cobbly clay loam; AWC- about 3"; located on convex areas of backslopes.</p> <p>Pearsoll (25%): Shallow; well drained; surface- v. cobbly clay loam/ 4" depth; subsoil- extremely cobbly clay; AWC- about 1"; located narrow summits, shoulders, convex areas of backslopes.</p> <p>Eightlar (25%): Very deep; well drained; surface- v. stony clay loam/ 13" depth; subsoil- extremely stony clay; AWC- about 4"; located on concave areas of backslopes.</p>	<p>Gravecreek, Pearsoll, and Eightlar—toxicity, slope, susceptibility of the surface layer to water erosion, cobbles and stones on the surface, susceptibility of the surface layer to displacement and accelerated erosion, susceptibility of the surface layer to compaction when wet, slope stability, south aspects, droughtiness in summer, low available water capacity.</p> <p>Gravecreek and Pearsoll—soil depth.</p> <p>Pearsoll and Eightlar—clayey textures, high shrink-swell potential.</p> <p>Eightlar—very slow permeability.</p> <p>Pearsoll—slow permeability.</p>
176F	Milbury-Umpcoos-Dystrochrepts complex, warm, 30 to 60 percent north slopes	Loamy-skeletal, mixed, mesic Typic Haplumbrepts	<p>Milbury (40%): Moderately deep; well drained; surface- v. gravelly loam/ 13" depth; subsoil- v. gravelly loam and v. cobbly loam; AWC- about 4"; located on concave areas of backslopes.</p> <p>Umpcoos (30%): Shallow; well drained; surface- v. gravelly sandy loam/ 3" depth; subsoil- extremely gravelly loam; AWC- about 1"; located on narrow summits, shoulders,</p>	<p>Milbury, Umpcoos, and Dystrochrepts—slope, susceptibility of the surface layer to water erosion, susceptibility of the surface layer to displacement and accelerated erosion, susceptibility of the surface layer to compaction when wet, slope stability, soil depth, low available water capacity.</p>

			and convex areas of backslopes. Dystrochrepts (20%): Moderately deep to very deep; well drained to excessively drained; surface- gravelly loam to v. cobbly sandy loam/8' depth; subsoil-extremely stony clay loam to extremely gravelly sandy loam; AWC- about 1 to 4"; located on convex areas of backslopes.	
182F	Mislatnah-Redflat-Greggo complex, 30 to 60 percent north slopes	Loamy-skeletal, serpentinic, mesic Dystric Eutrochrepts	Mislatnah (35%): Moderately deep; well drained; surface- cobbly clay loam/ 2" depth; subsoil-cobbly clay loam and v. cobbly clay loam; AWC- about 4"; located on convex areas of backslopes. Redflat (30%): Very deep; well drained; surface- gravelly loam/ 7" depth; subsoil- gravelly clay loam and gravelly silty clay loam; AWC- about 9"; located on footslopes, concave areas of backslopes. Greggo (25%): Shallow; well drained; surface- v. cobbly clay loam; subsoil- extremely gravelly clay loam; AWC- about 1"; located on narrow summits, shoulders and convex areas of backslopes.	Mislatnah, Redflat, and Greggo —toxicity, slope, susceptibility of the surface layer to water erosion, susceptibility of the surface layer to displacement and accelerated erosion, susceptibility of the surface layer to compaction when wet, slope stability. Mislatnah and Greggo —soil depth, low available water capacity.
230E	Serpentano-Mislatnah complex, 3 to 30 percent slopes	Loamy-skeletal, serpentinic, mesic Dystric Eutrochrepts	Serpentano (45%): Deep; well drained; surface- v. stony loam/ 6" depth; subsoil- v. gravelly clay loam; AWC- about 6"; located on concave areas of summits. Mislatnah (40%): Moderately deep; well drained; surface- cobbly clay loam/ 2" depth; subsoil- cobbly clay loam and v. cobbly clay loam; AWC- about 4"; located on convex areas of summits.	Serpentano and Mislatnah —toxicity, susceptibility of the surface layer to water erosion, susceptibility of the surface layer to compaction when wet, slope stability Mislatnah —susceptibility of the surface layer to displacement and accelerated erosion, soil depth, low available water capacity.
232F	Serpentano-Mislatnah-Greggo complex, 30 to 60 percent south slopes	Loamy-skeletal, serpentinic, mesic Dystric Eutrochrepts	Serpentano (35%): Deep; well drained; surface- v. stony loam/ 6" depth; subsoil- v. gravelly clay loam; AWC- about 6"; located on concave areas of backslopes; Mislatnah (30%): Moderately deep; well drained; surface- cobbly clay loam/ 2" depth; subsoil- cobbly clay loam and v. cobbly clay loam; AWC- about 4"; located on convex areas of backslopes. Greggo (25%): Shallow; well drained; surface- v. cobbly clay loam/ 4" depth; subsoil- extremely gravelly clay loam; AWC- about 1"; located on narrow summits, shoulders, and convex areas of backslopes.	Serpentano, Mislatnah, and Greggo —toxicity, slope, susceptibility of the surface layer to water erosion, susceptibility of the surface layer to displacement and accelerated erosion, susceptibility of the surface layer to compaction when wet, slope stability, south aspects. Mislatnah and Greggo —soil depth, low available water capacity.

240E	Snowcamp-Cedarcamp-Flycatcher complex, 0 to 30 percent slopes	Loamy-skeletal, serpentinic, frigid Dystric Eutrochrepts	<p>Snowcamp (35%): Moderately deep; well drained; surface- v. cobbly loam 4" depth; subsoil- v. cobbly clay loam and extremely cobbly clay loam; AWC- about 3"; located on convex areas of summits.</p> <p>Cedarcamp (30%): Very deep; well drained; surface- v. gravelly loam/6" depth; subsoil- v. cobbly clay loam, extremely cobbly loam, and extremely cobbly clay loam; AWC- about 5"; located on concave areas of summits.</p> <p>Flycatcher (25%): Shallow; well drained; surface- v. cobbly loam/ 4" depth; subsoil- v. gravelly clay loam, v. gravelly sandy clay loam, and extremely gravelly loam; AWC- about 2"; located on shoulders, knobs, convex areas of summits.</p>	<p>Snowcamp, Cedarcamp, and Flycatcher— toxicity, susceptibility of the surface layer to compaction when wet, duration of snow cover, short growing season, frost heave, slope stability, low available water capacity.</p> <p>Snowcamp and Flycatcher— susceptibility of the surface layer to water erosion, soil depth.</p>
242G	Snowcamp-Flycatcher-Rock outcrop complex, 60 to 90 percent south slopes	Loamy-skeletal, serpentinic, frigid Dystric Eutrochrepts	<p>Snowcamp (35%): Moderately deep; well drained; surface- v. bouldery loam 4" depth; subsoil- v. cobbly clay loam and extremely cobbly clay loam; AWC- about 3"; located on concave areas of backslopes.</p> <p>Flycatcher (30%): Shallow; well drained; surface- v. bouldery loam/ 4" depth; subsoil- v. gravelly clay loam, v. gravelly sandy clay loam, and extremely gravelly loam; AWC- about 2"; located on convex areas of backslopes.</p> <p>Rock outcrop (25%): Located on ridge crests and shoulders.</p>	<p>Snowcamp and Flycatcher— toxicity, slope, boulders on the surface, susceptibility of the surface layer to water erosion, susceptibility of the surface layer to displacement and accelerated erosion, susceptibility of the surface layer to compaction when wet, duration of snow cover, short growing season, frost heave, slope stability, soil depth, south aspects, low available water capacity.</p>

Table 20. Candidate Plantation soil characteristics and management limitations of the Shasta Agness Planning Area.

Map Unit	Map Unit Name	Taxonomic Classification	Soil Characteristics	Major Management Limitations	Soil Restoration Potential
5F	Althouse-Jayar-Skymor complex, 30 to 60 percent south slopes	Loamy-skeletal, mixed, frigid Dystric Xerochrepts	<p>Althouse (40%): Deep; well drained; surface- v. gravelly loam/3"; subsoil- v. gravelly loam; AWC- about 4"; located on concave areas of backslopes.</p> <p>Jayar (30%): Moderately deep; well drained; surface- v. gravelly loam/ 4"; subsoil- very gravelly loam; AWC- about 3"; located on convex areas of backslopes.</p> <p>Skymor (20%): shallow; well drained; surface- very gravelly loam/5"; subsoil- v. gravelly loam; AWC- about 1"; located on narrow summits, shoulders, convex areas of backslopes.</p>	<p>Althouse, Jayar, and Skymor— slope, susceptibility of the surface layer to water erosion, susceptibility of the surface layer to displacement and accelerated erosion, susceptibility of the surface layer to compaction when wet, duration of snow cover, short growing season, frost heave, slope stability, south aspects, droughtiness in summer, low available water capacity.</p> <p>Jayar and Skymor— soil depth.</p>	High Potential

8E	Atring-Kanid-Vermisa complex, 12 to 30 percent slopes	Loamy-skeletal, mixed, mesic Dystric Xerochrepts	<p>Atring (35%): Moderately deep; well drained; surface- v. gravelly loam/ 7" depth; subsoil- v. gravelly clay loam, v. gravelly loam; AWC- about 3"; located on convex areas of summits.</p> <p>Kanid (30%): Deep; well drained; surface- v. gravelly loam/5" depth; subsoil- v. gravelly clay loam; AWC- about 4"; located on concave areas of summits.</p> <p>Vermisa (25%): Shallow; somewhat excessively drained; surface- v. gravelly loam/3" depth; subsoil- extremely gravelly loam; AWC- about 1"; located on shoulders, convex areas of summits.</p>	Atring, Kanid, and Vermisa —susceptibility of the surface layer to compaction when wet, droughtiness in summer, low available water capacity.	High Potential
9G	Atring-Kanid-Vermisa complex, 60 to 90 percent south slopes	Loamy-skeletal, mixed, mesic Dystric Xerochrepts	<p>Atring (35%): Moderately deep; well drained; surface- v. gravelly loam/ 7" depth; subsoil- v. gravelly clay loam and v. gravelly loam; AWC- about 3"; located on convex areas of backslopes.</p> <p>Kanid (30%): Deep; well drained; surface- v. gravelly loam/5" depth; subsoil- v. gravelly clay loam; AWC- about 4"; located on concave areas of backslopes.</p> <p>Vermisa (25%): Shallow; somewhat excessively drained; surface- v. gravelly loam/3" depth; subsoil- extremely gravelly loam; AWC- about 1"; located on narrow summits, shoulders, convex areas of backslopes.</p>	<p>Atring, Kanid, and Vermisa—slope, susceptibility of the surface layer to water erosion, susceptibility of the surface layer to displacement and accelerated erosion, susceptibility of the surface layer to compaction when wet, slope stability, south aspects, droughtiness in summer, low available water capacity.</p> <p>Atring and Vermisa—soil depth.</p>	High Potential
9F	Atring-Kanid-Vermisa complex, 30 to 60 percent south slopes	Loamy-skeletal, mixed, mesic Dystric Xerochrepts	<p>Atring (40%): Moderately deep; well drained; surface- v. gravelly loam/ 7" depth; subsoil- v. gravelly clay loam and v. gravelly loam; AWC- about 3"; located on convex areas of backslopes.</p> <p>Kanid (30%): Deep; well drained; surface- v. gravelly loam/5" depth; subsoil- v. gravelly clay loam; AWC- about 4";</p>	Atring, Kanid, and Vermisa —slope, susceptibility of the surface layer to water erosion, susceptibility of the surface layer to displacement and accelerated erosion, susceptibility of the surface layer to compaction when wet, slope stability, south aspects, droughtiness in summer, low available water capacity.	High Potential

			located on concave areas of backslopes. Vermisa (20%): Shallow; somewhat excessively drained; surface- v. gravelly loam/3" depth; subsoil- extremely gravelly loam; AWC- about 1"; located on narrow summits, shoulders, convex areas of backslopes.		
13G	Atring-Vermisa complex, 60 to 90 percent north slopes	Loamy-skeletal, mixed, mesic Dystric Xerochrepts	Atring (50%): Moderately deep; well drained; surface- v. gravelly loam/ 7" depth; subsoil- v. gravelly clay loam and v. gravelly loam; AWC- about 3"; located on convex areas of backslopes. Vermisa (35%): Shallow; somewhat excessively drained; surface- v. gravelly loam/3" depth; subsoil- extremely gravelly loam; AWC- about 1"; located on narrow summits, shoulders, convex areas of backslopes.	Atring and Vermisa— slope, susceptibility of the surface layer to water erosion, susceptibility of the surface layer to displacement and accelerated erosion, susceptibility of the surface layer to compaction when wet, slope stability, soil depth, droughtiness in summer, low available water capacity.	High Potential
20E	Bearcamp-Brandypeak complex, 0 to 30 percent slopes	Loamy-skeletal, mixed, frigid Typic Xerumbrepts	Bearcamp (45%): Deep; well drained; surface- very gravelly loam/ 12" depth; subsoil- very gravelly loam, extremely gravelly loam, extremely gravelly loam; AWC- about 4"; located on concave areas of summits. Brandypeak (40%): Moderately deep; well drained; surface- very cobbly loam/ 10" depth; subsoil- very cobbly loam and extremely cobbly loam; AWC- about 3"; located on convex areas of summits.	Bearcamp and Brandypeak— susceptibility of the surface layer to compaction when wet, duration of snow cover, short growing season, frost heave, droughtiness in summer, low available water capacity. Brandypeak— susceptibility of the surface layer to water erosion, soil depth.	High Potential
21F	Bearcamp-Brandypeak-Woodseye complex, 30 to 60 percent north slopes	Loamy-skeletal, mixed, frigid Typic Xerumbrepts	Bearcamp (40%): Deep; well drained; surface- very gravelly loam/ 12" depth; subsoil- very gravelly loam, extremely gravelly loam, extremely gravelly loam; AWC- about 4"; located on concave areas of backslopes. Brandypeak (30%): Moderately deep; well drained; surface- very cobbly loam/ 10" depth; subsoil- very	Bearcamp, Brandypeak, and Woodseye— slope, susceptibility of the surface layer to water erosion, susceptibility of the surface layer to compaction when wet, duration of snow cover, short growing season, frost heave, slope stability, droughtiness in summer, low available water capacity. Brandypeak and Woodseye— soil depth.	High Potential

			<p>cobbly loam and extremely cobbly loam; AWC- about 3"; located on convex areas of backslopes.</p> <p>Woodseye (20%): Shallow; well drained or somewhat excessively drained; surface- very gravelly loam/ 12" depth; subsoil- extremely gravelly loam; AWC- about 1"; located on narrow summits, shoulders, convex areas of backslopes.</p>		
22F	Beekman-Colestine-Orthents complex, 30 to 60 percent south slopes	Loamy-skeletal, mixed, mesic Dystric Xerochrepts	<p>Beekman (40%): Moderately deep; well drained; surface- gravelly loam/ 5" depth; subsoil- v. gravelly loam and v. gravelly clay loam; AWC- about 3"; located on convex areas of backslopes.</p> <p>Colestine (30%): Moderately deep; well drained; surface- gravelly loam/ 5" depth; subsoil- gravelly loam and gravelly clay loam; AWC- about 4"; located on concave areas of backslopes.</p> <p>Orthents (20%): Depth varies from shallow to deep; well drained to excessively drained; surface- extremely gravelly sandy loam to extremely cobbly clay loam/ 5" depth; subsoil- extremely gravelly loamy sand to extremely cobbly clay loam; AWC- about 0.2 to 6"; located on narrow summits, shoulders, and convex areas of backslopes.</p>	<p>Beekman, Colestine, and Orthents- slope, susceptibility of the surface layer to water erosion, susceptibility of the surface layer to displacement and accelerated erosion, susceptibility of the surface layer to compaction when wet, slope stability, soil depth, south aspects, droughtiness in summer, low available water capacity.</p> <p>Orthents—moderately rapid to very rapid permeability.</p>	High Potential
25G	Beekman-Vermisa complex, 60 to 90 percent south slopes	Loamy-skeletal, mixed, mesic Dystric Xerochrepts	<p>Beekman (45%): Moderately deep; well drained; surface- gravelly loam/ 5" depth; subsoil- v. gravelly loam and v. gravelly clay loam; AWC- about 3"; located on convex areas of backslopes.</p> <p>Vermisa (40%): Shallow; somewhat excessively drained; surface- v. gravelly loam/ 3" depth; subsoil- extremely gravelly loam; AWC- about 1"; located on narrow summits, shoulders, and convex areas of backslopes.</p>	<p>Beekman and Vermisa—slope, susceptibility of the surface layer to water erosion, susceptibility of the surface layer to displacement and accelerated erosion, susceptibility of the surface layer to compaction when wet, slope stability, soil depth, south aspects, droughtiness in summer, low available water capacity.</p>	High Potential

35G	Brandypeak-Bearcamp-Woodseye complex, 60 to 90 percent north slopes	Loamy-skeletal, mixed, frigid Typic Xerumbrepts	<p>Brandypeak (35%): Moderately deep; well drained; surface-very cobbly loam/ 10" depth; subsoil- very cobbly loam and extremely cobbly loam; AWC- about 3"; located on convex areas of backslopes.</p> <p>Bearcamp(30%): Deep; well drained; surface- very gravelly loam/ 12" depth; subsoil- very gravelly loam, extremely gravelly loam, extremely gravelly loam; AWC- about 4"; located on concave areas of backslopes.</p> <p>Woodseye (25%): Shallow; well drained or somewhat excessively drained; surface- very gravelly loam/ 12" depth; subsoil- extremely gravelly loam; AWC- about 1"; located on narrow summits, shoulders, convex areas of backslopes.</p>	Brandypeak, Bearcamp, and Woodseye —slope, susceptibility of the surface layer to water erosion, susceptibility of the surface layer to compaction when wet, duration of snow cover, short growing season, frost heave, slope stability, droughtiness in summer, low available water capacity. Brandypeak and Woodseye —soil depth.	High Potential
85F	Digger-Preacher-Bohannon complex, warm, 30 to 60 percent south slopes	Fine-loamy, mixed, mesic Andic Haplumbrepts	<p>Digger (40%): Moderately deep; well drained; surface - v. gravelly loam/16" depth; subsoil - v. gravelly loam, and v. cobbly loam; AWC- about 3"; located on convex areas of backslopes.</p> <p>Preacher (30%): Very deep; well drained; surface- gravelly loam/ 14" depth; subsoil- clay loam and loam; AWC- about 10"; located on footslopes and concave areas of backslopes.</p> <p>Bohannon (20%): Moderately deep; well drained; surface- gravelly loam/ 14" depth; subsoil- gravelly loam; AWC- about 5"; located on concave areas of backslopes.</p>	Digger, Preacher, and Bohannon —slope, susceptibility of the surface layer to water erosion, susceptibility of the surface layer to displacement and accelerated erosion, susceptibility of the surface layer to compaction when wet, slope stability, south aspects. Digger and Bohannon —soil depth, low available water capacity.	High Potential
88F	Digger-Remote-Umpcoos complex, warm, 30 to 60 percent south slopes	Loamy-skeletal, mixed, mesic Dystric Eutrochrepts	<p>Digger (35%): Moderately deep; well drained; surface - v. gravelly loam/16" depth; subsoil - v. gravelly loam, and v. cobbly loam; AWC- about 3"; located on convex areas of backslopes.</p> <p>Remote (30%): Very deep; well drained;</p>	Digger, Remote, and Umpcoos —slope, susceptibility of the surface layer to water erosion, susceptibility of the surface layer to displacement and accelerated erosion, susceptibility of the surface layer to compaction when wet, slope stability, south aspects.	High Potential

			<p>surface- v. gravelly loam/ 6" depth; subsoil- gravelly loam and v. gravelly clay loam; AWC- about 6"; located on concave areas of backslopes.</p> <p>Umpcoos (25%): Shallow; well drained; surface- v. gravelly sandy loam/ 3" depth; subsoil- extremely gravelly loam; AWC- about 1"; located on narrow summits, shoulders, convex areas of backslopes.</p>	<p>Digger and Umpcoos— soil depth, low available water capacity.</p>	
91G	Digger-Umpcoos-Dystrochrepts complex, warm, 60 to 90 percent south slopes	Loamy-skeletal, mixed, mesic Dystric Eutrochrepts	<p>Digger (35%): Moderately deep; well drained; surface - v. gravelly loam/16" depth; subsoil - v. cobbly loam; AWC- about 3"; located on concave areas of backslopes.</p> <p>Umpcoos (30%): Shallow; well drained; surface- v. gravelly sandy loam/ 3"; subsoil- extremely gravelly loam; AWC- about 1"; located on narrow summits, shoulders, convex areas of backslopes.</p> <p>Dystrochrepts (25%): Moderately deep to very deep; well drained to excessively drained; surface- extremely gravelly loam to v. cobbly sandy loam/8" depth; subsoil- extremely stony clay loam to extremely gravelly sandy loam; AWC- about 1 to 4"; located on convex areas of backslopes.</p>	<p>Digger, Umpcoos, and Dystrochrepts— slope, susceptibility of the surface layer to water erosion, susceptibility of the surface layer to displacement and accelerated erosion, susceptibility of the surface layer to compaction when wet, slope stability, soil depth, south aspects, low available water capacity.</p>	High Potential
99E	Dumont-Acker-Kanid complex, 0 to 30 percent slopes	Clayey, kaolinitic, mesic Typic Palexerults	<p>Dumont (40%): Very Deep; well drained; surface- gravelly loam/ 5"; subsoil- red silty clay and clay loam; AWC- about 15"; located on concave areas of summits.</p> <p>Acker (30%): Very Deep; well drained; surface- gravelly loam/9"; subsoil- gravelly clay loam; AWC- about 9"; located on gently sloping areas of summits.</p> <p>Kanid (20%): Deep; well drained; surface- v. gravelly loam/5";</p>	<p>Dumont, Acker, and Kanid— susceptibility of the surface layer to compaction when wet, droughtiness in summer.</p> <p>Dumont and Acker— susceptibility of the surface layer to displacement and accelerated erosion.</p> <p>Dumont— clayey textures.</p> <p>Kanid— low available water capacity.</p>	High Potential

			subsoil- v. gravelly clay loam and weathered sandstone; AWC- about 4"; located on convex areas of summits.		
104E	Eightlar-Gravcreek-Pearsoll complex, 3 to 30 percent slopes	Clayey-skeletal, serpentinitic, mesic Typic Xerochrepts	<p>Eightlar (35%): Very deep; well drained; surface- v. stony clay loam/ 13" depth; subsoil- extremely stony clay; AWC- about 4"; located on concave areas of summits.</p> <p>Gravcreek (30%): Moderately deep; well drained; surface- v. cobbly loam/ 4" depth; subsoil- v. gravelly loam, v. cobbly clay loam; AWC- about 3"; located on convex areas of summits.</p> <p>Pearsoll (25%): Shallow; well drained; surface- v. cobbly clay loam/ 4" depth; subsoil- extremely cobbly clay; AWC- about 1"; located on shoulders, knobs, convex areas of summits.</p>	<p>Eightlar, Gravcreek, and Pearsoll—toxicity, cobbles and stones on the surface, susceptibility of the surface layer to compaction when wet, slope stability, droughtiness in summer, low available water capacity.</p> <p>Eightlar and Pearsoll—clayey textures, high shrink-swell potential, very slow and slow permeability.</p> <p>Gravcreek and Pearsoll—soil depth.</p>	High Potential
108F	Etelka-Remote-Whobrey complex, 30 to 60 percent north slopes	Fine, mixed, mesic Oxyaquic Dystrochrepts	<p>Etelka (35%): Very deep; moderately well drained; surface- silt loam/ 8" depth; subsoil- silty clay loam, silty clay, and clay; AWC-about 11"; located on concave areas of backslopes.</p> <p>Remote (30%): Very deep; well drained; surface- gravelly loam/ 14" depth; subsoil- gravelly clay loam; AWC- about 6"; located on convex areas of backslopes.</p> <p>Whobrey (25%): Very deep; somewhat poorly drained; surface- silt loam/ 12" depth; subsoil-silty clay loam, (mottled) clay, and clay; AWC- about 8"; located on footslopes and concave areas of backslopes.</p>	<p>Etelka, Remote, and Whobrey—slope, susceptibility of the surface layer to water erosion, susceptibility of the surface layer to displacement and accelerated erosion, susceptibility of the surface layer to compaction when wet, slope stability.</p> <p>Etelka and Whobrey—high water table, limited rooting depth.</p>	High Potential
109F	Etelka-Remote-Whobrey complex, 30 to 60 percent south slopes	Fine, mixed, mesic Oxyaquic Dystrochrepts	<p>Etelka (35%): Very deep; moderately well drained; surface- silt loam/ 8" depth; subsoil- silty clay loam, silty clay, and clay; AWC-about 11"; located on concave areas of backslopes.</p>	<p>Etelka, Remote, and Whobrey—slope, susceptibility of the surface layer to water erosion, susceptibility of the surface layer to displacement and accelerated erosion, susceptibility of the surface layer to compaction when wet,</p>	High Potential

			<p>Remote (30%): Very deep; well drained; surface- gravelly loam/ 14"depth; subsoil- gravelly clay loam; AWC- about 6"; located on convex areas of backslopes.</p> <p>Whobrey (25%): Very deep; somewhat poorly drained; surface- silt loam/ 12" depth; subsoil- silty clay loam and clay; AWC- about 8"; located on footslopes, concave areas of backslopes.</p>	<p>slope stability, south aspects.</p> <p>Etelka and Whobrey— high water table, limited rooting depth.</p> <p>Remote—low available water capacity.</p>	
110D	Etelka-Whobrey-Remote complex, 7 to 15 percent slopes	Fine, mixed, mesic Oxyaquic Dystrochrepts	<p>Etelka (40%): Very deep; moderately well drained; surface- silt loam/ 8" depth; subsoil- silty clay loam, silty clay, and clay; AWC-about 11"; located on convex areas of summits.</p> <p>Whobrey (30%): Very deep; somewhat poorly drained; surface- silt loam/ 12" depth; subsoil- silty clay loam and clay; AWC- about 8"; located on concave areas of summits.</p> <p>Remote (20%): Very deep; well drained; surface- gravelly loam/ 14"depth; subsoil- gravelly clay loam; AWC- about 6"; located on shoulders, knobs, convex areas of summits.</p>	<p>Etelka, Whobrey, and Remote—susceptibility of the surface layer to displacement and accelerated erosion, susceptibility of the surface layer to compaction when wet, slope stability.</p> <p>Etelka and Whobrey— clayey textures, high water table, limited rooting depth, high shrink-swell potential, slow and very slow permeability.</p>	High Potential
110E	Etelka-Whobrey-Remote complex, 15 to 30 percent slopes	Fine, mixed, mesic Oxyaquic Dystrochrepts	<p>Etelka (40%): Very deep; moderately well drained; surface- silt loam/ 8" depth; subsoil- silty clay loam, silty clay, and clay; AWC-about 11"; located on convex areas of summits.</p> <p>Whobrey (30%): Very deep; somewhat poorly drained; surface- silt loam/ 12" depth; subsoil- silty clay loam and clay; AWC- about 8"; located on concave areas of summits.</p> <p>Remote (20%): Very deep; well drained; surface- gravelly loam/ 14"depth; subsoil- gravelly clay loam; AWC- about 6"; located on shoulders, knobs,</p>	<p>Etelka, Whobrey, and Remote—susceptibility of the surface layer to displacement and accelerated erosion, susceptibility of the surface layer to compaction when wet, slope stability.</p> <p>Etelka and Whobrey— clayey textures, high water table, limited rooting depth, high shrink-swell potential, slow and very slow permeability.</p>	High Potential

			convex areas of summits.		
124E	Gamelake-Tincup complex, 0 to 30 percent slopes	Loamy-skeletal, mixed, frigid Typic Haplumbrepts	<p>Gamelake (55%): Very deep; well drained; surface- very gravelly loam/ 13" depth; subsoil- very gravelly sandy loam, extremely gravelly sandy loam, and very gravelly coarse; AWC- about 5"; located on concave areas of summits.</p> <p>Tincup (30%): Moderately deep; well drained; surface- very cobbly loam/ 7" depth; subsoil- extremely cobbly loam; AWC- about 2"; located on convex areas of summits.</p>	<p>Gamelake and Tincup—susceptibility of the surface layer to compaction when wet, duration of snow cover, short growing season, frost heave, slope stability, low available water capacity.</p> <p>Tincup—susceptibility of the surface layer to water erosion, soil depth.</p>	High Potential
132F	Gravecreek-Eightlar-Pearsoll complex, 30 to 60 percent south slopes	Loamy-skeletal, serpentinitic, mesic Dystric Xerochrepts	<p>Gravecreek (35%): Moderately deep; well drained; surface- v. cobbly loam/ 4" depth; subsoil- v. gravelly clay loam and v. cobbly clay loam; AWC- about 3"; located on convex areas of backslopes.</p> <p>Eightlar (30%): Very deep; well drained; surface- v. stony clay loam/ 13" depth; subsoil- extremely stony clay; AWC- about 4"; located on concave areas of backslopes.</p> <p>Pearsoll (25%): Shallow; well drained; surface- v. cobbly clay loam/ 4" depth; subsoil- extremely cobbly clay; AWC- about 1"; located on narrow summits, shoulders, convex areas of backslopes.</p>	<p>Gravecreek, Eightlar, and Pearsoll- toxicity, slope, susceptibility of the surface layer to water erosion, cobbles and stones on the surface, susceptibility of the surface layer to displacement and accelerated erosion, susceptibility of the surface layer to compaction when wet, slope stability, south aspects, droughtiness in summer, low available water capacity.</p> <p>Eightlar and Pearsoll- clayey textures, high shrink-swell potential.</p> <p>Gravecreek and Pearsoll- soil depth.</p> <p>Eightlar- very slow permeability.</p> <p>Pearsoll- slow permeability.</p>	High Potential
140F	Haplumbrepts-Rock outcrop-Cryaquepts complex, 0 to 75 percent north slopes	Haplumbrepts	<p>Haplumbrepts (45%): shallow to very deep; well drained or somewhat excessively drained; surface- extremely gravelly sandy loam/ 9" depth; subsoil- extremely gravelly loam; AWC- about 1 to 4"; located on convex and concave areas of backslopes, shoulders, and knobs.</p> <p>Rock Outcrop (30%): located on headwalls, ridge crests, shoulders.</p>	<p>Haplumbrepts and Cryaquepts—susceptibility of the surface layer to displacement and accelerated erosion, susceptibility of the surface layer to compaction when wet, duration of snow cover, short growing season, frost heave.</p> <p>Haplumbrepts—slope, susceptibility of the surface layer to water erosion, cobbles and stones on the surface, slope stability, soil depth, low available water capacity.</p> <p>Cryaquepts—high water table, ponding, clayey</p>	High Potential

			<p>Cryaquepts (15%): Shallow to very deep; poorly drained or very poorly drained; surface- mottled, silty clay loam/ 11" depth; subsoil- mottled, silty clay; AWC- about 6 to 10"; located on concave areas of meadows.</p>	textures, limited rooting depth, slow or very slow permeability.	
155F	Jayar-Rock outcrop-Althouse complex, 30 to 60 percent south slope	Loamy-skeletal, mixed, frigid Dystric Xerochrepts	<p>Jayar (40%): Moderately deep; well drained; surface- very gravelly loam/ 4" depth; subsoil- very gravelly loam; AWC- about 3"; located on convex areas of back slopes.</p> <p>Rock Outcrop (30%): located on ridge crests, Shoulders.</p> <p>Althouse (20%): Deep; well drained; surface- very gravelly loam/ 3" depth; subsoil- very gravelly loam; AWC- about 4"; located on concave areas of backslopes.</p>	<p>Jayar and Althouse— slope, susceptibility of the surface layer to water erosion, susceptibility of the surface layer to displacement and accelerated erosion, susceptibility of the surface layer to compaction when wet, duration of snow cover, short growing season, frost heave, slope stability, south aspects, droughtiness in summer, low available water capacity. Jayar—soil depth.</p>	High Potential
156G	Jayar-Skymor-Althouse complex, 60 to 90 percent south slopes	Loamy-skeletal, mixed, frigid Dystric Xerochrepts	<p>Jayar (35%): Moderately deep; well drained; surface- very gravelly loam/ 4" depth; subsoil- very gravelly loam; AWC- about 3"; located on convex areas of back slopes.</p> <p>Skymor (30%): Shallow; well drained; surface- very gravelly loam/ 5" depth; subsoil- very gravelly loam; AWC- about 1"; located on narrow summits, shoulders, convex areas of backslopes.</p> <p>Althouse (25%): Deep; well drained; surface- very gravelly loam/ 3" depth; subsoil- very gravelly loam; AWC- about 4"; located on concave areas of backslopes.</p>	<p>Jayar, Skymor, and Althouse—slope, susceptibility of the surface layer to water erosion, susceptibility of the surface layer to displacement and accelerated erosion, susceptibility of the surface layer to compaction when wet, duration of snow cover, short growing season, frost heave, slope stability, south aspects, droughtiness in summer, low available water capacity. Jayar and Skymor—soil depth.</p>	High Potential
158F	Kanid-Acker-Atring complex, 30 to 60 percent north slopes	Loamy-skeletal, mixed, mesic Dystric Xerochrepts	<p>Kanid (40%): Deep; well drained; surface- gravelly loam/ 5" depth; subsoil- v. gravelly clay loam; AWC- 4"; located on concave areas of backslopes.</p> <p>Acker (30%): Very deep; well drained; surface- gravelly loam/ 9" depth; subsoil- gravelly clay loam;</p>	<p>Kanid, Acker, and Atring—slope, susceptibility of the surface layer to water erosion, susceptibility of the surface layer to displacement and accelerated erosion, susceptibility of the surface layer to compaction when wet, slope stability, droughtiness in summer. Kanid and Atring—low</p>	High Potential

			<p>AWC- about 9"; located on footslopes, concave areas of backslopes.</p> <p>Atring (20%): Moderately deep; well drained surface- v. gravelly loam/ 7" depth; subsoil- v. gravelly clay loam and v. gravelly loam; AWC- about 3"; located on convex areas of backslopes.</p>	<p>available water capacity.</p> <p>Atring—soil depth.</p>	
159F	Kanid-Acker-Atring complex, 30 to 60 percent south slopes	Loamy-skeletal, mixed, mesic Dystric Xerochrepts	<p>Kanid (35%): Deep; well drained; surface- gravelly loam/ 5" depth; subsoil- v. gravelly clay loam; AWC- 4"; located on concave areas of backslopes.</p> <p>Acker (30%): Very deep; well drained; surface- gravelly loam/ 9" depth; subsoil- gravelly clay loam; AWC- about 9"; located on footslopes, concave areas of backslopes..</p> <p>Atring (25%): Moderately deep; well drained surface- v. gravelly loam/ 7" depth; subsoil- v. gravelly clay loam and v. gravelly loam; AWC- about 3"; located on convex areas of backslopes.</p>	<p>Kanid, Acker, and Atring—slope, susceptibility of the surface layer to water erosion, susceptibility of the surface layer to displacement and accelerated erosion, susceptibility of the surface layer to compaction when wet, slope stability, south aspects, droughtiness in summer</p> <p>Kanid and Atring—low available water capacity.</p> <p>Atring—soil depth.</p>	High Potential
174F	Milbury-Remote-Umpcoos complex, warm, 30 to 60 percent north slopes	Loamy-skeletal, mixed, mesic Typic Haplobrepts	<p>Milbury (40%): Moderately deep; well drained; surface- v. gravelly loam/ 13" depth; subsoil- v. gravelly loam and v. cobbly loam; AWC- about 4"; located on convex areas of backslopes.</p> <p>Remote (30%): Very deep; well drained surface- very gravelly loam/ 6"; subsoil- gravelly loam and v. gravelly clay loam; AWC- about 6"; located on concave areas of backslopes.</p> <p>Umpcoos (20%): Shallow; well drained; surface- v. gravelly sandy loam/ 3" depth; subsoil- extremely gravelly loam; AWC- about 1"; located on shoulders, knobs, and convex areas of backslopes.</p>	<p>Milbury, Remote, and Umpcoos—slope, susceptibility of the surface layer to water erosion, susceptibility of the surface layer to displacement and accelerated erosion, susceptibility of the surface layer to compaction when wet, slope stability.</p> <p>Milbury and Umpcoos—soil depth, low available water capacity.</p>	High Potential
175G	Milbury-Umpcoos-Dystrochrepts	Loamy-skeletal, mixed, mesic Typic	Milbury (40%): Moderately deep; well drained; surface-	Milbury, Umpcoos, and Dystrochrepts —slope,	High Potential

	complex, 60 to 90 percent north slopes	Haplumbrepts	<p>v. gravelly loam/ 13" depth; subsoil- v. gravelly loam and v. cobbly loam; AWC- about 4"; located on concave areas of backslopes.</p> <p>Umpcoos (30%): Shallow; well drained; surface- v. gravelly sandy loam/ 3" depth; subsoil- extremely gravelly loam; AWC- about 1"; located on narrow summits, shoulders, and convex areas of backslopes.</p> <p>Dystrochrepts (20%): Moderately deep to very deep; well drained to excessively drained; surface- gravelly loam to v. cobbly sandy loam/ 8' depth; subsoil- extremely stony clay loam to extremely gravelly sandy loam; AWC- about 1 to 4"; located on convex areas of backslopes.</p>	susceptibility of the surface layer to water erosion, susceptibility of the surface layer to displacement and accelerated erosion, susceptibility of the surface layer to compaction when wet, slope stability, soil depth, low available water capacity.	
176G	Milbury-Umpcoos-Dystrochrepts complex, warm, 60 to 90 percent north slopes	Loamy-skeletal, mixed, mesic Typic Haplumbrepts	<p>Milbury (40%): Moderately deep; well drained; surface- v. gravelly loam/ 13" depth; subsoil- v. gravelly loam and v. cobbly loam; AWC- about 4"; located on concave areas of backslopes.</p> <p>Umpcoos (30%): Shallow; well drained; surface- v. gravelly sandy loam/ 3" depth; subsoil- extremely gravelly loam; AWC- about 1"; located on narrow summits, shoulders, and convex areas of backslopes.</p> <p>Dystrochrepts (20%): Moderately deep to very deep; well drained to excessively drained; surface- gravelly loam to v. cobbly sandy loam/ 8' depth; subsoil- extremely stony clay loam to extremely gravelly sandy loam; AWC- about 1 to 4"; located on convex areas of backslopes.</p>	Milbury, Umpcoos, and Dystrochrepts —slope, susceptibility of the surface layer to water erosion, susceptibility of the surface layer to displacement and accelerated erosion, susceptibility of the surface layer to compaction when wet, slope stability, soil depth, low available water capacity.	High Potential
197E	Pollard-Josephine-Shastacosta complex, 2 to 30 percent slopes	Clayey, kaolinitic, mesic Typic Palexerults	Pollard (40%): Very deep; well drained; surface-gravelly loam/ 10" depth; subsoil- clay loam and silty clay; AWC- about 10"; located on	Pollard, Josephine, and Shastacosta —slope, susceptibility of the surface layer to compaction when wet, droughtiness in summer	High Potential

			<p>concave areas of summits.</p> <p>Josephine (30%): Deep; well drained; surface- gravelly loam/ 15" depth; subsoil- gravelly clay loam; AWC- 8"; located on convex areas of summits.</p> <p>Shastacosta (20%): Very deep; well drained; surface- v. gravelly loam/ 22" depth; subsoil- v. gravelly clay loam, extremely cobbly clay loam; v. cobbly clay loam, and v. gravelly clay; AWC- about 6"; located on concave areas of summits.</p>	<p>Pollard—clayey textures. Josephine—susceptibility of the surface layer to displacement and accelerated erosion. Shastacosta—high shrink-swell potential, slow permeability.</p>	
198E	Preacher-Blachly complex, warm, 0 to 30 percent slopes	Fine-loamy, mixed, mesic Andic Haplumbrepts	<p>Preacher (45%): Very deep; well drained; surface- clay loam/ 6" depth; subsoil- gravelly loam; clay loam, and loam; AWC- about 10"; located on convex areas of summits.</p> <p>Blachly (40%): Very deep; well drained; surface- silty clay loam/ 7" depth; subsoil- silty clay loam and silty clay; AWC- about 10" located on concave areas of summits.</p>	<p>Preacher and Blachly—susceptibility of the surface layer to compaction when wet, slope stability. Blachly—susceptibility of the surface layer to displacement and accelerated erosion, clayey textures.</p>	High Potential
201F	Preacher-Digger-Bohannon complex, warm, 30 to 60 percent north slopes	Fine-loamy, mixed, mesic Andic Haplumbrepts	<p>Preacher (35%): Very deep; well drained; surface- clay loam/ 6" depth; subsoil- gravelly loam; clay loam, and loam; AWC- about 10"; located on concave areas of backslopes.</p> <p>Digger (30%): Moderately deep; well drained; surface - v. gravelly loam/ 16" depth; subsoil - v. cobbly loam; AWC- about 3"; located on narrow summits, shoulders, convex areas of backslopes.</p> <p>Bohannon (25%): Moderately deep; well drained; surface- gravelly loam/ 14" depth; subsoil- gravelly loam; AWC- about 5"; located on convex areas of backslopes.</p>	<p>Preacher, Digger, and Bohannon—slope, susceptibility of the surface layer to water erosion, susceptibility of the surface layer to displacement and accelerated erosion, susceptibility of the surface layer to compaction when wet, slope stability. Digger and Bohannon—soil depth, low available water capacity.</p>	High Potential
233F	Shastacosta-Pollard-Beekman	Loamy-skeletal, mixed,	Shastacosta (35%): very deep; well	Shastacosta, Pollard, and Beekman —slope,	High Potential

	complex, 30 to 60 percent south slopes	mesic Typic Palexerults	<p>drained; surface- v. gravelly loam/ 22" depth; subsoil- v. gravelly clay loam, extremely cobbly clay loam, v. cobbly clay, and v. gravelly clay; AWC- about 6"; located on concave areas of backslopes.</p> <p>Pollard (30%): Very deep; well drained; surface- loam/ 10" depth; subsoil- clay loam and silty clay; AWC- about 10"; located on footslopes, concave areas of backslopes.</p> <p>Beekman (25%): Moderately deep; well drained; surface- gravelly loam/ 5" depth; subsoil- v. gravelly loam and v. gravelly clay loam; AWC- about 3"; located on narrow summits, shoulders, convex areas of backslopes.</p>	<p>susceptibility of the surface layer to water erosion, susceptibility of the surface layer to displacement and accelerated erosion, susceptibility of the surface layer to compaction when wet, slope stability, south aspects, droughtiness in summer.</p> <p>Shastacosta—high shrink-swell potential, slow permeability.</p> <p>Pollard—clayey textures.</p> <p>Beekman—soil depth, low available water capacity.</p>	
239G	Skymor-Rock outcrop-Jayar complex, 60 to 90 percent south slopes	Loamy-skeletal, mixed, frigid Dystric Lithic Xerochrepts	<p>Skymore (35%): Shallow; well drained; surface- very gravelly loam/ 5" depth; subsoil- very gravelly loam; AWC- about 1"; located on narrow summits, shoulders, convex areas of backslopes.</p> <p>Rock Outcrop (30%): Located on ridge crests and shoulders.</p> <p>Jayar (25%): Moderately deep; well drained; surface- very gravelly loam/ 4" depth; subsoil- very gravelly loam; AWC- about 3"; located on convex areas of backslopes.</p>	<p>Skymor and Jayar—slope, susceptibility of the surface layer to water erosion, susceptibility of the surface layer to displacement and accelerated erosion, susceptibility of the surface layer to compaction when wet, duration of snow cover, short growing season, frost heave, slope stability, soil depth, south aspects, droughtiness in summer, low available water capacity.</p>	Moderate Potential
244G	Stackyards-Rilea-Euchrand complex, cool, 60 to 90 percent north slopes	Loamy-skeletal, mixed, frigid Typic Haplumbrepts	<p>Stackyards (35%): Deep, well drained; surface- extremely gravelly loam/ 10" depth; subsoil- cobbly clay loam and extremely cobbly clay loam; AWC- about 4"; located on concave areas of backslopes.</p> <p>Rilea (30%): Moderately deep; well drained; surface- very gravelly loam/ 5" depth; subsoil- very gravelly loam and very gravelly clay loam; AWC- about 3"; located on convex areas of backslopes.</p>	<p>Stackyards, Rilea, and Euchrand—slope, susceptibility of the surface layer to water erosion, duration of snow cover, short growing season, frost heave, slope stability, low available water capacity.</p> <p>Rilea and Euchrand—susceptibility of the surface layer to displacement and accelerated erosion, susceptibility of the surface layer to compaction when wet, soil depth.</p>	High Potential

			<p>Eucland (25%): Shallow; well drained; surface- very gravelly loam/ 3" depth; subsoil- extremely gravelly loam; AWC- about 1"; located on narrow summits, shoulders, convex areas of backslopes.</p>		
245G	Stackyards-Rilea-Eucland complex, 60 to 90 percent north slopes	Loamy-skeletal, mixed, frigid Typic Haplumbrepts	<p>Stackyards (35%): Deep, well drained; surface- extremely gravelly loam/ 10" depth; subsoil- cobbly clay loam and extremely cobbly clay loam; AWC- about 4"; located on footslopes and concave areas of backslopes.</p> <p>Rilea (30%): Moderately deep; well drained; surface- very gravelly loam/5" depth; subsoil- very gravelly loam ad very gravelly clay loam; AWC- about 3"; located on convex areas of backslopes.</p> <p>Eucland (25%): Shallow; well drained; surface- very gravelly loam/ 3" depth; subsoil- extremely gravelly loam; AWC- about 1"; located on narrow summits, shoulders, convex areas of backslopes.</p>	<p>Stackyards, Rilea, and Eucland—slope, susceptibility of the surface layer to water erosion, duration of snow cover, short growing season, frost heave, slope stability, low available water capacity.</p> <p>Rilea and Eucland—susceptibility of the surface layer to displacement and accelerated erosion, susceptibility of the surface layer to compaction when wet, soil depth.</p>	High Potential
250F	Stackyards-Rilea-Yorel complex, cool, 30 to 60 percent north slopes	Loamy-skeletal, mixed, frigid Typic Haplumbrepts	<p>Stackyards (40%): Deep, well drained; surface- extremely gravelly loam/ 10" depth; subsoil- cobbly clay loam and extremely cobbly clay loam; AWC- about 4"; located on concave areas of backslopes.</p> <p>Rilea (30%): Moderately deep; well drained; surface- very gravelly loam/5" depth; subsoil- very gravelly loam ad very gravelly clay loam; AWC- about 3"; located on convex areas of backslopes.</p> <p>Yorel (20%): Moderately deep; well drained; surface- gravelly loam/ 6" depth; subsoil- gravelly loam and gravelly clay loam; AWC- about 4"; located on footslopes</p>	<p>Stackyards, Rilea, and Yorel—slope, susceptibility of the surface layer to water erosion, duration of snow cover, short growing season, frost heave, slope stability, low available water capacity.</p> <p>Rilea and Yorel—susceptibility of the surface layer to displacement and accelerated erosion, susceptibility of the surface layer to compaction when wet, soil depth.</p>	High Potential

			and concave areas of backslopes.		
251F	Stackyards-Rilea-Yorel complex, 30 to 60 percent north slopes	Loamy-skeletal, mixed, frigid Typic Haplumbrepts	<p>Stackyards (40%): Deep, well drained; surface- extremely gravelly loam/ 10" depth; subsoil- cobbly clay loam and extremely cobbly clay loam; AWC- about 4"; located on concave areas of backslopes.</p> <p>Rilea (30%): Moderately deep; well drained; surface- very gravelly loam/5" depth; subsoil- very gravelly loam and very gravelly clay loam; AWC- about 3"; located on narrow summits, shoulders, convex areas of backslopes.</p> <p>Yorel (20%): Moderately deep; well drained; surface- gravelly loam/ 6" depth; subsoil- gravelly loam and gravelly clay loam; AWC- about 4"; located on convex areas of backslopes.</p>	<p>Stackyards, Rilea, and Yorel—slope, susceptibility of the surface layer to water erosion, duration of snow cover, short growing season, frost heave, slope stability, low available water capacity.</p> <p>Rilea and Yorel—susceptibility of the surface layer to displacement and accelerated erosion, susceptibility of the surface layer to compaction when wet, soil depth.</p>	High Potential
265F	Tolfork-Tincup complex, 30 to 60 percent north slopes	Loamy-skeletal, mixed, frigid Pachic Haplumbrepts	<p>Tolfork (55%): Deep, well drained; surface- very gravelly coarse sandy loam/ 9" depth; subsoil- extremely gravelly sandy loam and extremely cobbly sandy loam; AWC- about 3"; located on concave areas of backslopes.</p> <p>Tincup (30%): Moderately deep; well drained; surface- very cobbly loam/ 7" depth; subsoil- extremely cobbly loam; AWC- about 2"; located on convex areas of backslopes.</p>	<p>Tolfork and Tincup—slope, susceptibility of the surface layer to water erosion, susceptibility of the surface layer to displacement and accelerated erosion, duration of snow cover, short growing season, frost heave, slope stability, low available water capacity.</p> <p>Tincup—susceptibility of the surface layer to compaction when wet, soil depth.</p>	High Potential
265G	Tolfork-Tincup complex, 60 to 90 percent north slopes	Loamy-skeletal, mixed, frigid Pachic Haplumbrepts	<p>Tolfork (55%): Deep, well drained; surface- very gravelly coarse sandy loam/ 9" depth; subsoil- extremely gravelly sandy loam and extremely cobbly sandy loam; AWC- about 3"; located on concave areas of backslopes.</p> <p>Tincup (30%): Moderately deep; well drained; surface- very cobbly loam/ 7" depth; subsoil- extremely cobbly loam; AWC- about</p>	<p>Tolfork and Tincup—slope, susceptibility of the surface layer to water erosion, susceptibility of the surface layer to displacement and accelerated erosion, duration of snow cover, short growing season, frost heave, slope stability, low available water capacity.</p> <p>Tincup—susceptibility of the surface layer to compaction when wet, soil depth.</p>	High Potential

			2"; located on convex areas of backslopes.		
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Appendix 2: Soil Characteristics and Management Limitations of Recreation and Aquatic/Habitat Improvements

Table 21. Proposed trail soil characteristics and management limitations of the Shasta Agness Planning Area.

Name Recreation Trail	Map Unit	Map Unit Name	Taxonomic Classification	Soil Characteristics	Major Management Limitations
Big Bend Battlefield trail	1D 61A	Abegg gravelly loam, 7 to 20 percent slopes Clawson sandy loam, 0 to 3 percent slopes	Loamy-skeletal, mixed, mesic Ultic Haploxeralfs Coarse-loamy, mixed, nonacid, mesic Typic Endoaquepts	Abegg (85%): Very deep; well drained; surface- gravelly loam/ 11" depth; subsoil- gravelly loam; extremely cobbly clay loam, and extremely gravelly loamy sand; AWC- about 5"; located on convex areas, high stream terraces and alluvial fans. Clawson (85%): Very deep; poorly drained; surface- sandy loam/ 5" depth; subsoil- sandy loam and coarse sandy loam; AWC- about 7"; Located on concave areas and low stream terraces.	Abegg- Slope, susceptibility of the surface layer to compaction when wet, droughtiness in summer, low available water capacity. Clawson- High water table, susceptibility of the surface layer to compaction when wet, droughtiness in summer, limited rooting depth, moderately rapid permeability.
Foster Cr to Brewery Hole trail	57A 61A 257A	See above for 61A Central Point sandy loam, 0 to 3 percent slopes Takilma cobbly loam, 0 to 3 percent slopes	See above for 61A Coarse-loamy, mixed, mesic Pachic Haploxerolls Loamy-skeletal, mixed, mesic Entic Ultic Haploxerolls	See above for 61A Central Point (85%): Very deep; well drained; surface- sandy loam/ 43" depth; subsoil- gravelly sandy loam; AWC- about 6"; located on low stream terraces. Takilma (85%): Very deep; well drained; surface- cobbly loam/ 5" depth; subsoil- very cobbly loam and extremely cobbly sandy loam; AWC- about 4"; located on low stream terraces.	See above for 61A Central Point- Susceptibility of the surface layer to compaction when wet, droughtiness in summer, moderately rapid permeability. Takilma- Susceptibility of the surface layer to compaction when wet, droughtiness in summer, low available water capacity, cobbles on the surface.
Foster/Brewery tie-in w/Up. Rogue trail	61A 257A	See above for 61A and 257A	See above for 61A and 257A	See above for 61A and 257A	See above for 61A and 257A
FSR 2308330 to OHV trail	13G 158F 267F	Atring-Vermisa complex, 60 to 90 percent north slopes Kaniid-Acker-Atring complex, 30 to 60 percent north slopes Vermisa-Beekman-Colestine complex, 30 to 60 percent south slopes	Loamy-skeletal, mixed, mesic Dystric Xerochrepts Loamy-skeletal, mixed, mesic Dystric Xerochrepts Loamy-skeletal, mixed,	See Oak Savannah (Table 8) and Candidate Plantations (Table 11) for soil characteristics of 13G, 158F, and 267F.	See Oak Savannah (Table 8) and Candidate Plantations (Table 11) for soil management limitations of 13G, 158F, and 267F.

			mesic Lithic Xerochrepts		
FSR 3577350 to OHV trail	9G 13G 25G 159F 197E 233F	Atring-Kanid- Vermisa complex, 60 to 90 percent south slopes See above for 13G Beekman-Vermisa complex, 60 to 90 percent south slopes Kanid-Acker-Atring complex, 30 to 60 percent south slopes Pollard-Josephine- Shastacosta complex, 2 to 30 percent slopes Shastacosta-Pollard- Beekman complex, 30 to 60 percent south slopes	Loamy-skeletal, mixed, mesic Dystric Xerochrepts See above for 13G Loamy-skeletal, mixed, mesic Dystric Xerochrepts Loamy-skeletal, mixed, mesic Dystric Xerochrepts Clayey, kaolinitic, mesic Typic Palexerults Loamy-skeletal, mixed, mesic Typic Palexerults	See Oak Savannah (Table 8) and Candidate Plantations (Table 11) for soil characteristics of 9G, 13G, 25G, 159F, 197E, and 233F.	See Oak Savannah (Table 8) and Candidate Plantations (Table 11) for soil management limitations of 9G, 13G, 25G, 159F, 197E, and 233F.
Nancy Cr trail 1181 decommissioned	13G 99E 189G 233F	See Oak Savannah (Table 8) and Candidate Plantations (Table 11) for soil characteristics of 13G and 233F. Dumont-Acker- Kanid complex, 0 to 30 percent slopes Pearsoll-Gravecreek- Rock outcrop complex, 60 to 90 percent south Slopes	See Oak Savannah (Table 8) and Candidate Plantations (Table 11) for soil characteristics of 13G and 233F. Clayey, kaolinitic, mesic Typic Palexerults Clayey-skeletal, serpentinic, mesic Lithic Xerochrepts	See Oak Savannah (Table 8) and Candidate Plantations (Table 11) for soil characteristics of 13G and 233F. Dumont (40%): Very Deep; well drained; surface- gravelly loam/5" depth; subsoil- silty clay and clay loam; AWC- about 15"; located on concave areas of summits. Acker (30%): Very deep; well drained; surface- gravelly loam/ 9" depth; subsoil- gravelly clay loam; AWC- about 9"; located on gently sloping areas of summits. Kanid (20%): Deep; well drained; surface- very gravelly loam/ 5" depth; subsoil- very gravelly clay loam; AWC- about 4"; located on convex areas of summits. Pearsoll (35%): Shallow; well drained; surface- v. cobbly clay loam/ 4" depth; subsoil- extremely cobbly clay; AWC- about 1"; located on narrow summits, shoulders, and convex areas of backslopes. Gravecreek (30%): Moderately deep; well drained; surface- v. cobbly loam/ 4" depth; subsoil- v. gravelly clay loam and v. cobbly clay loam; AWC- about 3";	See Oak Savannah (Table 8) and Candidate Plantations (Table 11) for soil management limitations of 13G and 233F. Dumont, Acker, and Kanid— susceptibility of the surface layer to compaction when wet, droughtiness in summer. Dumont and Acker— susceptibility of the surface layer to displacement and accelerated erosion. Dumont— clayey textures. Kanid— low available water capacity. Pearsoll and Gravecreek— toxicity, slope, susceptibility of the surface layer to water erosion, cobbles on the surface, susceptibility of the surface layer to displacement and accelerated erosion, susceptibility of the surface layer to compaction when wet, slope stability, soil depth, south aspects, droughtiness in summer, low available water capacity.

				located on convex areas of backslopes.	
				Rock Outcrop (25%): Located on ridge crests and shoulders.	
Shasta Costa Creek trail	13G 61A 94F 105F 131G 189G 197E 233F 267F	See Oak Savannah (Table 8), Serpentine Pine (Table 10), Candidate Plantations (Table 11), and above for 13G, 61A, 105F, 189G, 197E, 233F, and 267F Dubakella-Cornutt-Pearsoll complex, 20 to 60 percent south slopes Gravescreek-Eightlar-Pearsoll complex, 60 to 90 percent north slopes	See Oak Savannah (Table 8), Serpentine Pine (Table 10), Candidate Plantations (Table 11), and above for 13G, 61A, 105F, 189G, 197E, 233F, and 267F Clayey-skeletal, serpentinic, mesic Mollic Haploxeralfs Loamy-skeletal, serpentinic, mesic Dystric Xerochrepts	See Oak Savannah (Table 8), Serpentine Pine (Table 10), Candidate Plantations (Table 11), and above for 13G, 61A, 105F, 189G, 197E, 233F, and 267F Dubakella (40%): Moderately deep; well drained; surface- very cobble clay loam/ 13" depth; subsoil- very cobbly clay; AWC- about 2"; located on convex areas of backslopes. Cornutt (30%): Deep; well drained; surface- cobbly clay loam/ 11" depth; subsoil- gravelly clay and cobbly clay; AWC- about 6"; located on concave areas of backslopes. Pearsoll (20%): Shallow; well drained; surface- very cobbly clay loam/ 4" depth; subsoil- extremely cobbly clay; AWC- about 1"; locate on narrow summits, shoulders, convex areas of backslopes. Gravescreek (40%): Moderately deep; well drained; surface- v. cobbly loam/ 4" depth; subsoil- v. gravelly clay loam and v. cobbly clay loam; AWC- about 3"; located on convex areas of backslopes. Eightlar (30%): Very deep; well drained; surface- v. stony clay loam/ 13" depth; subsoil- extremely stony clay; AWC- about 4"; located on concave areas of backslopes. Pearsoll (20%): Shallow; well drained; surface- v. cobbly clay loam/ 4" depth; subsoil- extremely cobbly clay; AWC- about 1"; located on narrow summits, shoulders, convex areas of backslopes.	See Oak Savannah (Table 8), Serpentine Pine (Table 10), Candidate Plantations (Table 11), and above for 13G, 61A, 105F, 189G, 197E, 233F, and 267F Dubakella, Cornutt, and Pearsoll —toxicity, slope, susceptibility of the surface layer to water erosion, cobbles on the surface, susceptibility of the surface layer to displacement and accelerated erosion, susceptibility of the surface layer to compaction when wet, clayey textures, slope stability, south aspects, droughtiness in summer, high shrink-swell potential, slow permeability. Dubakella and Pearsoll —soil depth, low available water capacity. Gravescreek, Eightlar, and Pearsoll —toxicity, slope, susceptibility of the surface layer to water erosion, cobbles and stones on the surface, susceptibility of the surface layer to displacement and accelerated erosion, susceptibility of the surface layer to compaction when wet, slope stability, droughtiness in summer, low available water capacity. Eightlar and Pearsoll —clayey textures, high shrink-swell potential Gravescreek and Pearsoll —soil depth. Eightlar —very slow permeability. Pearsoll —slow permeability.

Shasta Costa Overlook A	9F 11F 12G 20E 155F 160G	See Candidate Plantations (Table 11) for soil map unit descriptions and characteristics of 9F, 20E, and 155F.	See Candidate Plantations (Table 11) for soil map unit descriptions and characteristics of 9F, 20E, and 155F.	See Candidate Plantations (Table 11) for soil map unit descriptions and characteristics of 9F, 20E, and 155F	See Candidate Plantations (Table 11) for soil map unit descriptions and characteristics of 9F, 20E, and 155F
		<p>Atring-Rock outcrop- Kanid complex, 30 to 60 percent south slopes</p> <p>Atring-Rock outcrop- Vermisa complex, 60 to 90 percent south slopes</p> <p>Kanid-Atring complex, 60 to 90 percent north slopes</p>	<p>Loamy-skeletal, mixed, mesic Dystric Xerochrepts</p> <p>Loamy-skeletal, mixed, mesic Dystric Xerochrepts</p> <p>Loamy-skeletal, mixed, mesic Dystric Xerochrepts</p>	<p>Atring (35%): Moderately deep: well drained; surface- v. gravelly loam/ 7" depth; subsoil- v. gravelly clay loam and v. gravelly loam; AWC- about 3"; located on convex areas of backslopes.</p> <p>Rock Outcrop (30%): Located on ridge crests and shoulders.</p> <p>Kanid (25%): Deep; well drained; surface- v. gravelly loam/5" depth; subsoil- v. gravelly clay loam; AWC- about 4"; located on concave areas of backslopes.</p> <p>Atring (35%): Moderately deep: well drained; surface- v. gravelly loam/ 7" depth; subsoil- v. gravelly clay loam and v. gravelly loam; AWC- about 3"; located on convex areas of backslopes.</p> <p>Rock Outcrop (30%): Located on ridge crests and shoulders.</p> <p>Vermisa (25%): Shallow; somewhat excessively drained; surface- v. gravelly loam/3" depth; subsoil- extremely gravelly loam; AWC- about 1"; located on narrow summits, shoulders, convex areas of backslopes.</p> <p>Kanid (45%): Deep; well drained; surface- v. gravelly loam/5" depth; subsoil- v. gravelly clay loam; AWC- about 4"; located on concave areas of backslopes.</p> <p>Atring (40%): Moderately deep: well drained; surface- v. gravelly loam/ 7" depth; subsoil- v. gravelly clay loam and v. gravelly loam; AWC- about 3"; located on convex areas of backslopes.</p>	<p>Kanid, Vermisa, and Atring—slope, susceptibility of the surface layer to water erosion, susceptibility of the surface layer to displacement and accelerated erosion, susceptibility of the surface layer to compaction when wet, slope stability, droughtiness in summer, low available water capacity. Atring and Vermisa—soil depth and south aspects</p>

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Shasta Costa Overlook B	11F 20E	See above for 11F and Table 11 for 20E	See above for 11F and Table 11 20E	See above for 11F and Table 11 for 20E	See above for 11F and Table 11 for 20E
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Table 22. Proposed recreation site soil characteristics and management limitations of the Shasta Agness Planning Area.

Recreation Site Name	Map Unit	Map Unit Name	Taxonomic Classification	Soil Characteristics	Major Management Limitations
Billings Cr Dispersed Campground Decommissioned	61A 257A	See Table 12 for 61A and 257A.	See Table 12 for 61A and 257A.	See Table 12 for 61A and 257A.	See Table 12 for 61A and 257A.
Foster Bar Facility Maintained	9G 112A 214	See Table 8 for 9G and 112A. Riverwash	See Table 8 for 9G and 112A. NA	See Table 8 for 9G and 112A. Very deep; excessively drained to poorly drained; sandy and gravelly alluvium; AWC- about 1"; located in areas adjacent to rivers and streams that consist of sand and gravel and do not support vegetation.	See Table 8 for 9G and 112A. Flooding, high water table, susceptibility to water erosion, rapid permeability, low available water capacity.
Foster Bar Launch Improved	214	See above for 214	See above for 214	See above for 214	See above for 214
Illahee CG Decommission	9F 221B	See Table 8 for 9F and 221B.	See Table 8 for 9F and 221B.	See Table 8 for 9F and 221B.	See Table 8 for 9F and 221B.
Illahee CG Reopening	1B 9F 196D 221B	See Table 8 for 1B, 9F, 196D, and 221B.	See Table 8 for 1B, 9F, 196D, and 221B.	See Table 8 for 1B, 9F, 196D, and 221B.	See Table 8 for 1B, 9F, 196D, and 221B.
Illinois TH Horse Camp (new)	196D	See Table 8 for 196D.	See Table 8 for 196D.	See Table 8 for 196D.	See Table 8 for 196D.
Oak Flat CG Boat Ramp/Water	112A 196D 214	See Table 8 for 112A and 196D, and above for 214.	See Table 8 for 112A and 196D, and above for 214.	See Table 8 for 112A and 196D, and above for 214.	See Table 8 for 112A and 196D, and above for 214.
Oak Flat CG Host	112A 214	See Table 8 for 112A and above for 214.	See Table 8 for 112A and above for 214.	See Table 8 for 112A and above for 214.	See Table 8 for 112A and above for 214.
Shasta Costa Campground (new)	61A 197E	See Table 8 for 61A and 197E.	See Table 8 for 61A and 197E.	See Table 8 for 61A and 197E.	See Table 8 for 61A and 197E.
Shasta Costa Maintenance	267F	See Table 8 for 267F.	See Table 8 for 267F.	See Table 8 for 267F.	See Table 8 for 267F.
Upper Rogue TH Improvements	1D 61A	See Table 12 for 1D and 61A.	See Table 12 for 1D and 61A.	See Table 12 for 1D and 61A.	See Table 12 for 1D and 61A.

Table 23. Proposed stream restoration soil characteristics and management limitations of the Shasta Agness Planning Area.

Name of Stream	Map Unit	Map Unit Name	Taxonomic Classification	Soil Characteristics	Major Management Limitations
Billings Creek	9G 22F 61A 257A	See Table 8 for 9G, 22F, and 61A. See Table 12 for 257A.	See Table 8 for 9G, 22F, and 61A. See Table 12 for 257A.	See Table 8 for 9G, 22F, and 61A. See Table 12 for 257A.	See Table 8 for 9G, 22F, and 61A. See Table 12 for 257A.
Foster Creek	1B 9F 13G 57A	See Table 8 for 1B, 9F, 61A, 112A, and 131G; see Table 9 for 232F; see Table 10	See Table 8 for 1B, 9F, 61A, 112A, and 131G; see Table 9 for 232F; see Table 10	See Table 8 for 1B, 9F, 61A, 112A, and 131G; see Table 9 for 232F; see Table 10	See Table 8 for 1B, 9F, 61A, 112A, and 131G; see Table 9 for 232F; see Table 10

	61A 91F 91G 112A 131G 132F 158F 176G 232F 257A	for 91F; see Table 11 for 13G, 91G, 158F, and 176G; see Table 12 for 57A and 257A.	for 91F; see Table 11 for 13G, 91G, 158F, and 176G; see Table 12 for 57A and 257A.	for 91F; see Table 11 for 13G, 91G, 158F, and 176G; see Table 12 for 57A and 257A.	for 91F; see Table 11 for 13G, 91G, 158F, and 176G; see Table 12 for 57A and 257A.
Lawson Creek	13G 136G 158F 182F 257A	See Table 8 for 158F; see Table 10 for 182F; see Table 11 for 13G; see Table 12 for 257A. Greggo-Rock outcrop- Mislatah complex, 60 to 90 percent north Slopes	See Table 8 for 158F; see Table 10 for 182F; see Table 11 for 13G; see Table 12 for 257A. Loamy-skeletal, serpentinic, mesic Lithic Eutrochrepts	See Table 8 for 158F; see Table 10 for 182F; see Table 11 for 13G; see Table 12 for 257A. Greggo (35%): Shallow, well drained; surface-very cobbly clay loam/ 4" depth; subsoil- extremely gravelly clay loam; AWC- about 1"; located on convex areas of backslopes. Rock Outcrop (30%): Located on ridge crests and shoulders. Mislatah (25%): Moderately deep, well drained; surface- cobbly clay loam/ 2" depth; subsoil- cobbly clay loam and very cobbly clay loam; AWC- about 4"; located on concave areas of backslopes.	See Table 8 for 158F; see Table 10 for 182F; see Table 11 for 13G; see Table 12 for 257A. Greggo and Mislatah —toxicity, slope, susceptibility of the surface layer to water erosion, susceptibility of the surface layer to displacement and accelerated erosion, susceptibility of the surface layer to compaction when wet, slope stability, soil depth, low available water capacity.
Shasta Costa Creek	1D 13G 22F 23G 94F 105F 112A 131G 158F 160F 160G 189G 257A 267F	See Table 8 for 22F, 23G, 112A, 131G, 158F, and 267F; see Table 10 for 105F; see Table 11 for 13G; see Table 12 for 1D, 160G, 189G, and 257A. Kanid-Atring complex, 30 to 60 percent north slopes	See Table 8 for 22F, 23G, 112A, 131G, 158F, and 267F; see Table 10 for 105F; see Table 11 for 13G; see Table 12 for 1D, 160G, 189G, and 257A. Loamy-skeletal, mixed, mesic Dystric Xerochrepts	See Table 8 for 22F, 23G, 112A, 131G, 158F, and 267F; see Table 10 for 105F; see Table 11 for 13G; see Table 12 for 1D, 160G, 189G, and 257A. Kanid (50%): Deep, well drained; surface- v. gravelly loam/5" depth; subsoil- v. gravelly clay loam; AWC- about 4"; located on concave areas of backslopes. Atring (35%): Moderately deep; well drained; surface- v. gravelly loam/ 7" depth; subsoil- v. gravelly clay loam and v. gravelly loam; AWC- about 3"; located on convex areas of backslopes.	See Table 8 for 22F, 23G, 112A, 131G, 158F, and 267F; see Table 10 for 105F; see Table 11 for 13G; see Table 12 for 1D, 160G, 189G, and 257A. Kanid and Atring —slope, susceptibility of the surface layer to water erosion, susceptibility of the surface layer to displacement and accelerated erosion, susceptibility of the surface layer to compaction when wet, slope stability, droughtiness in summer, low available water capacity. Atring —soil depth.
Snout Creek	1D 13G 158F	See Table 11 for 13G and 158F; see Table 12 for 1D.	See Table 11 for 13G and 158F; see Table 12 for 1D.	See Table 11 for 13G and 158F; see Table 12 for 1D.	See Table 11 for 13G and 158F; see Table 12 for 1D.
Squirrel Camp Creek	160G	See Table 12 for 160G.	See Table 12 for 160G.	See Table 12 for 160G.	See Table 12 for 160G.

Stair Creek¹⁵	9G 13G 91G 108F 159F 160G 175G 176G 217	See Table 8 for 9G and 159F; see Table 11 for 13G, 91G, 108F, 175G, and 176G; see Table 12 for 160G. Rock outcrop-Orthents complex, 10 to 100 percent slopes	See Table 8 for 9G and 159F; see Table 11 for 13G, 91G, 108F, 175G, and 176G; see Table 12 for 160G NA	See Table 8 for 9G and 159F; see Table 11 for 13G, 91G, 108F, 175G, and 176G; see Table 12 for 160G Rock Outcrop (60%): Located on convex areas on ridge crests, backslopes, and shoulders that have hard bedrock at the surface and do not support vegetation. Orthents (35%): Shallow to very deep; well drained to excessively drained; surface- extremely gravelly sandy loam to extremely cobbly clay loam/ 5"depth; subsoil- extremely gravelly loamy sand to extremely cobbly clay loam; AWC- about 0.2" to 6"; located on backslopes, shoulders, and footslopes adjacent to areas of Rock outcrop.	See Table 8 for 9G and 159F; see Table 11 for 13G, 91G, 108F, 175G, and 176G; see Table 12 for 160G Orthents —slope, susceptibility of the surface layer to water erosion, cobbles and stones on the surface, susceptibility of the surface layer to displacement and accelerated erosion, duration of snow cover, short growing season, frost heave, slope stability, soil depth, poor anchoring medium, toxicity, droughtiness in summer, available water capacity, salt spray, permeability.
Twomile Creek	9G 13G 105F 158F 160F	See Table 8 for 9G and 158F; see Table 10 for 105F; see Table 11 for 13G; and see above for 160F.	See Table 8 for 9G and 158F; see Table 10 for 105F; see Table 11 for 13G; and see above for 160F.	See Table 8 for 9G and 158F; see Table 10 for 105F; see Table 11 for 13G; and see above for 160F.	See Table 8 for 9G and 158F; see Table 10 for 105F; see Table 11 for 13G; and see above for 160F.
Waters Creek	9F 158F	See Table 8 for 9F and 158F.	See Table 8 for 9F and 158F.	See Table 8 for 9F and 158F.	See Table 8 for 9F and 158F.

¹⁵ Outside of the Wild Rogue Wilderness

